AMERICAN SOCIETY FOR TESTING MATERIALS

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1937 Annual Meeting in New York City, June 28-July 2

Outstanding Technical Program and Exhibit Developing

SATISFACTORY progress is being made on the various features which promise to make the 1937 (Fortieth) Annual Meeting, to be held at The Waldorf-Astoria, New York City, June 28-July 2, a really outstanding one. The technical program, Exhibit of Testing Apparatus and Related Equipment, entertainment features, and the other items are developing rapidly.

Since the Society was incorporated in 1902, only one meeting has been held in New York City; that was in 1912 when there was an international congress on testing materials. The American section of the I.A.T.M. held a meeting in New York in 1900. It is a coincidence that the Fortieth Annual Meeting will be held just 25 years after the meeting in 1912.

The various subgroups of the New York Committee on Arrangements, of which Dr. M. F. Skinker, Brooklyn Edison Co., is chairman, have held meetings recently to perfect plans for the respective work in their charge. The enthusiasm and vigor with which the various problems are being handled augers well for the success of the meeting.

At the recent meeting of Committee E-6 on Papers and Publications, which is in charge of the technical program, a large number of offers of papers were reviewed. Some of the subjects which will be covered are mentioned below.

A most interesting Exhibit is developing with many of the prominent concerns in the testing apparatus, laboratory supply and instruments field participating and a number of committee and special research displays are in prospect.

TECHNICAL PROGRAM

As mentioned in the January BULLETIN, several groups of papers dealing with various phases of specific materials will be presented. The subject of asphalt will be well represented and the sessions in which the papers in this field will be presented should prove to be quite interesting.

The Symposium of Significance of Tests of Coals, as developed, contemplates seven papers covering the following topics: pulverizer performance as affected by grindability; significance of ash softening temperature and ash analysis in coal utilization; interpretation of proximate analysis, including calorific value, in terms of coal utilization; the significance of sulfur in coal to consumer; laboratory tests relating to caking, plastic, gas- and coke-making properties of bituminous coals; size stability of coal—tests for friability; and significance of tests for coke from the standpoint of blast-furnace and cupola utilization. This symposium is being developed under the sponsorship of Committee D-5 on Coal and Coke.

It is expected that a session of the meeting will be devoted to several papers on the subject of water, involving technique in the determination of traces of dissolved oxygen; some applications of the polarizing miscroscope to water-conditioning problems; a thermodynamic and colloidal interpretation of the published studies on the corrosion cracking of stressed mild steel in water solutions.

Another symposium being organized involves the subject Consistency: Critical Discussion of Present-Day Practices in Consistency Measurement. This is being planned by the technical committee of Committee E-1 on Methods of Testing covering consistency, plasticity and related subjects. The tentative outline of subjects which may be covered includes discussion of progress in consistency measurement, definitions and consideration of consistency in relation to such materials as paint, asphalt, tars, petroleum products and lubricants, naval stores, rubber and rubber compounds and others.

In addition to the symposiums and groups of papers on specific subjects, there will be a large number of other technical contributions dealing with various topics in the field of ferrous

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and non-ferrous metals, masonry materials and on the general subject of testing.

Complete preliminary details of the technical program will appear as usual in the April BULLETIN. This Provisional Program will include synopses of the many committee reports and technical papers which will be presented at the meeting.

HOTEL ACCOMMODATIONS

The Waldorf-Astoria is well equipped to handle meetings of the type of the A.S.T.M annual meeting. Special rates have been obtained for members of the Society and information concerning room rates together with an advance registration card will be sent to each member with the April BULLETIN. Members who may wish to make reservations immediately for the week of the annual meeting, may do so by addressing the hotel management mentioning that they are A.S.T.M. members.

EXHIBIT OF TESTING APPARATUS AND RELATED EQUIPMENT

In addition to displays covering latest developments in the instruments and laboratory supply field by some of the leading companies in the industry, a number of Society committees have indicated their intention of planning interesting exhibits of their work. The Joint Committee on Effect of Temperature on the Properties of Metals, Committee E-4 on Metallography, Committee D-9 on Electrical Insulating Materials, and others are developing material which should add considerably to the educational nature of the Exhibit.

Since the last exhibit, held in 1935, there have been a number of notable advances in the instrumentation field both in regard to testing and research instruments and in the recording and control field. A number of the companies listed below who have applied for space in the Exhibit, plan to display for the first time some of their newest developments and the various booths will contain products of interest to members and the large number of other technical and industrial executives who will visit the Exhibit.

The Exhibit will be held on The Waldorf's ballroom floor adjacent to the A.S.T.M. Registration Desk and the rooms in which the technical sessions for the annual meeting will be held. Companies which have indicated their intention to take part in the Exhibit include the following:

Ace Glass, Inc.
Amthor Testing Machine Co.
Atlas Electric Devices Co.
Baldwin-Southwark Corp.
Bausch & Lomb Optical Co.
Christian Becker, Inc.
Cambridge Instrument Co.
Central Scientific Co.
Eimer & Amend, Inc.
Federal Pneumatic Devices, Inc.
General Radio Co.
Great Western Mfg. Co.
The Emil Greiner Co.
The Instruments Publishing Co.
Leeds & Northrup Co.
E. Leitz, Inc.
"Metals and Alloys"
National Carbon Co.
Tinius Olsen Testing Machine Co.
Palo-Myers, Inc.
Parr Instrument Co.
Philips Metalix Corp.
Podbielniak Analytical and Research Labs.
Precision Scientific Co.
Radium Chemical Co.
Riehle Division, American Machine and Metals, Inc.
Henry L. Scott Co.
Shawmut Engineering Co.
Alfred Suter
The Standard Electric Time Co.
C. J. Tagliabue Mfg. Co.
Testing Machines, Inc.
Wilson Mechanical Instrument Co.
Carl Zeiss, Inc.

Two Symposiums Feature Regional Meeting

Corrosion Testing and Lubricants Discussed

Two extensive technical symposiums, one on corrosion testing procedure involving six papers, and the other on lubricants with four comprehensive papers, featured the 1937 A.S.T.M. Regional Meeting, held at the Palmer House, Chicago, on March 2 and 3. The Tuesday evening session was devoted to the corrosion symposium, while the Wednesday morning and afternoon sessions were given over to the symposium on lubricants.

Dr. F. N. Speller, of the National Tube Co., headed the committee which developed the papers in the corrosion testing symposium, other members representing Committees A-5 and B-3 being L. W. Hopkins, R. J. McKay and C. L. Hippensteel.

The Lubricants Symposium was developed by Technical Committee B on Motor Oils of Committee D-2, with H. C. Mougey, General Motors Corp., chairman, and J. G. Detwiler, The Texas Company, secretary. Messrs. J. B. Rather, R. P. Anderson and T. A. Rogers cooperated with the committee.

Doctor Speller served as chairman of the session on corrosion and D. P. Barnard, IV, Standard Oil Co. of Indiana, and F. L. Faulkner, Armour & Co., presided at the lubricants sessions.

Local arrangements for the Regional Meeting and for A.S.T.M. Committee Week were in charge of the Chicago A.S.T.M. District Committee, headed by W. A. Straw, Western Electric Co., with C. E. Ambelang, Public Service Company of Northern Illinois, secretary. D. L. Colwell, Stewart Die Casting Corp., chairman of the meetings and program subcommittee, and a number of other Chicago members, assisted in the work and handled arrangements for the regional meeting dinner. The attendance at the three sessions, about 350 in each, was indicative of the very definite interest on the part of leading organizations and technologists in the subjects discussed.

It is planned to publish the papers in the two symposiums and further announcements will be made concerning this. Attention is called to the notice on page 24 concerning the closing date for receipt of discussion.

SYMPOSIUM ON CORROSION TESTING PROCEDURE

The six papers in the corrosion symposium were as follows:

Principles of Corrosion Testing—C. W. Borgmann, National Tube Co., and R. B. Mears, Aluminum Company of America.

Atmospheric Corrosion Testing—H. S. Rawdon, Chief, Division of Metallurgy, National Bureau of Standards.

Salt Spray Testing—E. H. Dix, Jr., Chief Metallurgist, Aluminum Research Laboratories, Aluminum Company of America, and J. J. Bowman, Metallurgical Division, Aluminum Research Laboratories, Aluminum Company of America.

Alternate Immersion and Water-Line Tests—D. K. Crampton, Research Director, Chase Brass and Copper Co., Inc.

Total Immersion Tests—R. J. McKay and F. L. LaQue, The International Nickel Co.

Soil Corrosion Testing—K. H. Logan, S. P. Ewing and I. A. Denison, National Bureau of Standards.

Messrs. Borgmann and Mears in their paper on "Principles of Corrosion Testing," classified the various types of tests into three broad groups: (1) laboratory; (2) field; (3) service. After a brief review of the theory of corrosion (the authors adhered to the electro-chemical theory) there were discussed the various methods of estimating the rate of corrosion together with extent of corrosion. The authors stressed the advantage of "special property" tests over "accelerated corrosion" tests. It was indicated that of the five main aims of corrosion tests, the study of mechanism of corrosion is most basic. In conclusion, the authors listed certain tests on which in their opinion sufficient data are available to justify standardization. These were divided into laboratory tests (impingement attack, intercrystalline corrosion, corrosion-fatigue, partial immersion tests, spray tests, etc.), and field tests, including atmospheric exposure, soil corrosion and immersion tests. Tests which seem to require further work

W. A. Straw — H. C. Mougey — F. N. Speller

before standardization, under the general heading of laboratory tests, included stress corrosion, film breakdown tests, crevice tests, total and alternate immersion tests, and dezincification of brass.

Dr. H. S. Rawdon in discussing "Atmospheric Corrosion Testing," outlined methods and precautions used in conducting the tests, confining his comments largely to field tests. It was indicated that results of exposure tests should always be correlated with prevailing atmospheric conditions and that a close distinction must be drawn between tests aimed essentially to develop chemical characteristics and those intended for the acquisition of engineering corrosion data. A relatively large surface area with respect to the mass of the specimen was listed as always advantageous. Doctor Rawdon stated that the change in ductility is a more sensitive indicator of the effect of corrosion than the accompanying change in tensile strength.

In their paper on "Salt Spray Testing," Messrs. Dix and Bowman mentioned that long experience with this test indicates that results can be made reasonably reproducible and are of substantial value when properly interpreted. For comparison of similar materials or as an acceptance test for certain classes of materials, the test has much to recommend it, in the opinion of the authors, while for comparisons of radically different materials or as an accurate indication of service life in other than marine atmospheres, its use may be hazardous. A critical study of comparative summaries of many corrosion tests of aluminum alloys led the authors to the conclusion that the salt spray test is a reliable method for comparing aluminum alloys and can be used, with reserva-

tions and in combination with practical experience, in estimating the service life of these materials. The authors pointed out that to secure the best results from the salt spray test, standardization of operating procedures appeared desirable.

Rather extensive uses of the "Alternate Immersion and Water-Line Tests" were described by D. K. Crampton. The alternate immersion test is carried out by dipping specimens in and out of the solution at a definite rate. It was indicated that the results obtained with the test had indicated relative rates of corrosion of several alloys which were nearly in line with the relative behavior of these same alloys under generally similar service conditions.

Messrs. McKay and LaQue in their paper on "Total Immersion Tests" divided the experimental study of corrosion in liquids into two types, namely, theoretical studies and rate tests. The authors indicated that standardization in the field of theoretical studies was neither desirable nor possible but that with regard to rate tests, standardization was worth while because it improves mutual understanding and it was possible because it aids in obtaining reproducible results of practical use. A detailed analysis of reports on corrosion tests for 1925 to 1935 indicated that the tendency is almost universally toward better control and more complete recording. While the evaluation of results and units used to report them seems quite non-uniform, this was indicated as logical because the detailed purpose of the test may vary considerably from test to test. Three important factors which should be controlled in tests of the type covered were mentioned, namely, temperature, aeration and velocity.

Messrs. Logan, Ewing and Denison in their very extensive paper on "Soil Corrosion Testing" stated that the subject fell into two main divisions: (1) the influence of the nature of the metal and (2) the influence of the soil. A study of the corrosion of various metals in soils is largely a study of the properties of the soils which are important in corrosion. The authors pointed out that every soil condition is in a sense unique and that the rate of corrosion cannot be predicted in the absence of knowledge of the properties of the soils. From an analysis of data obtained from three sources, (1) service data on pipe lines, (2) field burial tests of selected metals, and (3) laboratory tests, the authors stated that it should be possible to devise a procedure to determine the corrosiveness of soils and express it in acceptable units.

A rational procedure for testing the corrosion of metals in soils involves: (1) the corrosiveness of the soil; (2) the relation between pit depth and area; and (3) the relation between pit depth and time. By means of an equation in which the depth of the deepest pit on a given area is expressed as a function of (1) the corrosiveness of the soil, (2) the area exposed, and (3) the period of exposure, the estimated depth of pit may be calculated to the desired area and time. A general equation was given for the estimation of the number of holes, if any, in pipe as a function of the corrosiveness of the soil, time and wall thickness.

SYMPOSIUM ON LUBRICANTS

The four technical papers comprising the Symposium on Lubricants were as follows:

Engine Deposits—Causes and Effects—W. A. Gruse and C. J. Livingstone, Mellon Institute of Industrial Research.

Automotive Bearings—Effect of Design and Composition on Lubrication—Arthur F. Underwood, Assistant Head, Power Plant Dept., Research Laboratories Section, General Motors Corp.

Addition Agents for Motor Oils—G. M. Maverick and R. G. Sloane, Standard Oil Company of New Jersey.

How to Select a Motor Oil from the Standpoint of the Consumer—W. S. James, Chief Engineer, The Studebaker Corp.

In their paper on "Engine Deposits—Causes and Effects" Messrs. Gruse and Livingstone discussed five general locations where collection of foreign material in engines may be expected, namely, combustion chamber, valves, under piston surfaces, piston rings and crankcase. In considering combustion chamber deposits, the authors indicated that while carbon deposition does not seem to constitute a bottle neck in further engine progress the reduction of such deposits by all means available will be of real assistance. They pointed out that there apparently was no common cause for or one type of ring fouling failure for all classes of engines. It appears that there is a type of ring clogging attributable to low-temperature duty and another arising in high temperatures. The latter is complicated by differences in oils and in engines and the problem remains a puzzling one. In concluding it was indicated that "if the engine designers can be encouraged to recognize the inherent limitations of organic compounds—lubricating oils and fuels—and at the same time the operators can be persuaded to stay within the limits for which their equipment was built and if, further, wise selection of fuels and lubricants is made, then the happy days of failure-less operation will be close at hand."

In a most interesting paper, A. F. Underwood pointed out that while a great deal of research work had been done on bearing design and lubrication, these were still largely matters of experience. Equipment for testing lubricated bearings was described and some of the important design factors of lubricated bearings were described in detail. The composition of bearing materials was discussed. The paper considered the subject of lubrication primarily from the standpoint of bearing performance and the author pointed out "that within somewhat wide limits the properties of the oil, other than viscosity, have little or nothing to do with bearing performance. However, in an internal combustion engine there are many other areas to be lubricated and the lubricant, in addition, must perform other functions. These other factors may require certain properties in lubricants, even though they may not be required by the bearings. Consequently, the problem of quality of oil is of very great importance and it is still necessary to use oil of proper quality for actual use in automobile engines."

Messrs. Maverick and Sloane in their paper on "Addition Agents for Motor Oils" traced developments as indicated by patents and outlined the purpose and commercial success of the agents and at the same time warned of complications which may be involved in their use. It was pointed out that the oil industry has improved the quality of lubricants to perhaps as great an extent as it has improved fuel. This has been achieved largely as an outcome of improvements in refining methods, but the best that can be expected from refining methods is limited by the nature of the oil itself. Oiliness agents, viscosity and viscosity index improvers, pour inhibitors, and oxidation and corrosion inhibitors have been used in hundreds of thousands of barrels of lubricating oils of the highest quality. They indicated that the crankcase oil

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Many Committees Meet in Chicago

Numerous Standards Recommendations To Be Made; Important Research Work Under Way

AT THE large number of meetings of committees of the Society held in Chicago at the Palmer House during Committee Week, March 1-4, a number of new specifications and standardized methods of tests were approved and subject to approval by confirming letter ballot of the respective committees, are to be submitted to the Society at the annual meeting in June in New York City for approval. Progress on many research projects now under way was reviewed and a number of new investigations are to be instituted. Throughout the week there were about 150 meetings of main committees, sections and sub-groups.

The total registration for Committee Week was 588. All of the meetings were very well attended and spirited discussion took place at several of them on important points.

The following committees held meetings and in the case of most of those listed a large number of subcommittee meetings were held prior to the main committee session:

- A-1 on Steel
- A-2 on Wrought Iron
- A-3 on Cast Iron
- A-5 on Corrosion of Iron and Steel
- A-10 on Iron-Chromium-Nickel Alloys
- B-1 on Copper and Copper Alloy Wires for Electrical Conductors
- B-3 Sub VI on Atmospheric Corrosion of Non-Ferrous Metals and Alloys
- B-5 Sub I on Wrought Metals and Alloys
- B-6 on Die-Cast Metals and Alloys
- B-7 on Light Metals and Alloys
- C-7 on Lime
- C-9 on Concrete and Concrete Aggregates
- C-13 on Concrete Pipe
- D-1 Sub XI on Paint Thinners Other Than Turpentine
- D-1 Sub XXVI on Underground Pipe Protection
- D-2 on Petroleum Products and Lubricants
- D-3 on Gaseous Fuels
- D-4 on Road and Paving Materials
- D-5 on Coal and Coke
- D-6 Sub IV on Paper Shipping Containers
- D-8 on Bituminous Waterproofing and Roofing Materials
- D-11 on Rubber Products
- D-15 on Thermometers and Laboratory Glassware
- D-18 on Soils for Engineering Purposes
- E-1 Section on Tension Testing
- E-1 Section on Elastic Strength of Materials
- E-1 Section on Calibration of Apparatus
- E-4 Sub on Grain Characteristics of Steel
- Research Committee on Fatigue of Metals
- Joint Committee on Effect of Temperature on the Properties of Metals
- Joint Committee on Exposure Tests of Plating on the Non-Ferrous Metals
- Sectional Committee Z11 on Petroleum Products and Lubricants

The outlines given below of various committee activities will give some idea of the progress made and of the programs which the committees have under way.

Most of the actions taken at the meetings will of course be submitted to letter ballot prior to formal recommendation to the Society at the annual meeting in June, this being particularly true in the case of actions in the standardization field. It will be noted that many new standards are being considered for recommendation to the Society for publication as tentative and that a number of existing tentative specifications and tests will be offered for formal adoption as A.S.T.M. standards.

Committee A-1 on Steel

Included in the existing tentative specifications which were recommended at the meeting of Committee A-1 on Steel for adoption as official standards are those covering the following materials: forged or rolled steel pipe flanges for general service (A 181), seamless cold-drawn heat-exchanger and condenser tubes, and still tubes for refinery service (A 179) and (A 161), and electric-resistance-welded steel and open-hearth iron boiler tubes (A 178). Other tentative specifications which will also be submitted to letter ballot of the committee for recommended adoption as standard cover fabricated steel bar or rod mats, and welded steel wire fabric for concrete reinforcement (A 184) and (A 185).

Several new specifications which have been in course of development during the past year were studied at the Steel Committee meetings and are to be referred to committee letter ballot for recommendation to the Society as new tentative standards. Products covered by some of these new specifications include: intermediate alloy-steel seamless steel still tubes and intermediate alloy-steel seamless cold-drawn heat-exchanger and condenser tubes. These are proposed as companion specifications to existing A.S.T.M. items for similar carbon and alloy steel products. The committee on boiler steels reported progress on a very active program which includes new specifications covering carbon steel, low carbon nickel steel and molybdenum steel plates of flange quality for locomotive boiler shells and of flange and firebox qualities for stationary boilers and other pressure vessels. These, and a new specification for chrome-manganese-silicon alloy steel boiler plate are being referred to the committee for approval.

An important new specification for iron and steel filler metal (arc welding electrodes and gas welding rods) was presented at the meeting and will be balloted upon. This was developed in joint cooperation with representatives of the American Welding Society. Seven grades of filler metal are included, designated as grades 2, 4, 10, 15, 20, 30 and 40, and classified according to tensile properties of the weld.

A number of questions of importance are being investigated by various divisions of Committee A-1. One of these involves the inclusion of surface conditioning requirements in the Tentative Specifications for Structural Nickel Steel (A 8 - 36 T). Subcommittee II, in charge of this work, has in hand, also, requests for standard specifications for steel sheet piling. An interesting development in the work of the Subcommittee on Steel Tubing and Pipe is the proposal to eliminate the use of Birmingham wire gage in the tube specifications and the substitution of a system of designating the wall thickness by decimals of an inch. A special subcommittee was appointed to develop recommendations at the June meeting concerning this matter and also the question of coordinating wall thickness tolerances in accordance with the change in method of designation. The committee has under preparation a new specification for alloy-steel boiler and superheater tubes for high pressure and high-temperature steam service.

One of the actions taken at the meeting, to be submitted to letter ballot, involved the withdrawal of the List of Specifications for Steel Suitable for Fusion Welding (A 151 - 35) with the recommendation that the existing specifications cov-

ering materials offered for fusion welding be revised to incorporate specific requirements for welding or to include a statement that the material is suitable for welding.

The standard specifications A 158 covering seamless alloy-steel pipe for high-temperature service are to be redrafted as a new tentative specification and because of the wide usage of the carbon-molybdenum alloy steel composition, especially by the power industry, in ranges of 900 to 1000 F., this grade will be removed from the specification and covered in a proposed new tentative standard. In the revised specifications A 158, three alloys are to be deleted because of the lack of demand and five new alloys are to be added.

Committee A-2 on Wrought Iron

A number of phases of the work in its charge were reviewed by Committee A-2 on Wrought Iron at the Chicago meeting. Plans were developed on a reorganization of certain of the subgroups and this will involve a consolidation of the two subcommittees on merchant bar iron and staybolt and engine-bolt iron. An important project under way in the subgroup on plates, shapes and sheets concerns the development of specification requirements for wrought-iron structural shapes.

Committee A-5 on Corrosion of Iron and Steel

Committee A-5, at its meeting approved the submission to the Society of two proposed tentative specifications which will serve as general revisions of the existing standard specifications for farm-field and railroad right-of-way fencing and for barbed wire. The new specification requirements differ from present standards primarily in the inclusion of three weight of coating classes for both fencing and barbed wire.

Active work is under way on the revision of existing specifications for strand, line wire and chain-link fencing, galvanized after weaving. New specification requirements for chain-link fencing, galvanized before weaving, are being studied. During the past year, the committee developed test methods for determining the uniformity of coating by the Preece test on zinc-coated wire (A 191). This test is referred to in the standard methods of determining weight and uniformity of coating on zinc-coated articles (A 90 - 33) and the committee agreed to retain this reference with a note to indicate that when wire is being tested, the method outlined in A 191 should be followed.

Inspection of the committee's country-wide outdoor exposure tests of bare and galvanized sheets and hardware and plated specimens is being continued. Installation of material in the committee's latest tests on wire, has been completed at the eleven test fields. Materials included in this work are plain unfabricated wire, barbed wire, wire strand, farm-fence and chain-link fencing. A detailed description of these tests appeared in the December, 1936, BULLETIN. Tests of the physical and chemical properties of all materials exposed in the wire tests are now being carried out at the National Bureau of Standards. The complete data resulting from this work will be published.

At the meeting of Subcommittee VII on Methods of Testing there was considerable discussion involving electroplated coatings. While at the last session of the committee consideration was given to the publication for trial and comment of promising test methods, no action was taken. There was discussion of various methods of thickness measurement including (a) metallographic, (b) stripping, (c) the chord method, (d) dropping, jet and spot tests and (e) magnetic methods. A new magnetic method devised for measuring the thickness of nickel coatings on non-ferrous base metals was demonstrated at the meeting and discussed at some length. There was also consideration of methods for measuring the porosity of coatings, and accelerated tests such as salt spray and intermittent immersion.

An extensive exhibit depicting the scope of the outdoor testing activities of Committee A-5 and several other A.S.T.M. committees doing similar work in other materials fields will be given at the Fortieth Annual Meeting of the Society, to be held June 28-July 2 at The Waldorf-Astoria in New York City.

Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys

The Subcommittee on Classification of Data reported at the meeting of Committee A-10 that active consideration is being given to the assemblying of information for data sheets covering the iron-chromium, iron-chromium-nickel and related alloys. The tables of Data on Chemical Compositions, Physical and Mechanical Properties and Corrosion-Resistant Properties of Corrosion-Resistant and Heat-Resistant Alloys, which were prepared by Committee A-10 in 1930, have had a wide circulation but there has been an urgent demand that this information be brought up to date in view of the many developments that have taken place since these tables were issued. It is planned that the new summary will be issued in the form of standard letter-size sheets and will cover authoritative information upon which there is general agreement within the committee for the various metals and alloys within the scope of the committee, including individual tables of information on each of the typical alloys and for the various forms in which the metals are fabricated.

The Subcommittee on Methods of Corrosion Testing reported that at its meeting the various methods of corrosion testing and the use of such tests were discussed. Subgroups will be appointed to give consideration to the preparation of details for recommended practices covering particular types of corrosion tests including the boiling liquid immersion test, the plain immersion test, the spray test and atmospheric exposure testing.

Committee A-10 has been very much interested in available information and data respecting the service behavior of stainless alloy steels and consideration was given to arrangements for the inspection of typical installations of such stainless metals after exposure. A special committee will investigate the possibilities of arranging for such inspections of existing installations on various structures throughout the country and prepare a report of their findings for consideration by the committee. In a number of instances it is quite possible that there is available information respecting the physical properties and manufacturing details of the metals that will be examined.

The committee also considered the need for a study of the relation between exposure behavior, that is, changes in appearance and in mechanical and metallurgical properties

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Glass Discussed at Pittsburgh Meeting

At a dinner meeting sponsored by the Pittsburgh District Committee held on February 25, at the Roosevelt Hotel, Pittsburgh, three papers on the subject of glass were presented. The meeting was arranged during the meetings of Committee D-9 on Electrical Insulating Materials and the program was planned so that it would be of interest to the members of this committee and also to bring the subject before the Society at a time when the newly authorized standing committee on glass was being organized. There were about 150 members and guests present during the session at which the papers were presented.

H. V. Churchill, Chief Chemist, Aluminum Company of America, served as toastmaster at the dinner, at which short talks were given by President Fieldner, Secretary-Treasurer Warwick, Dr. G. W. Morey, chairman of the Steering Committee responsible for the organization of the new Committee on Glass and Glass Products, and Dr. T. Smith Taylor, chairman of A.S.T.M. Committee D-9. Arrangements for the meeting were in the charge of Dean Harvey, Materials Engineer, Material and Process Engineering Dept., Westinghouse Electric and Manufacturing Co., and F. M. Howell, Engineer of Tests, Aluminum Research Laboratories, Aluminum Co. of America, chairman and secretary respectively of the Pittsburgh District Committee. Mr. J. S. Gregorius, Pittsburgh Plate Glass Co., and chairman of the Glass Division of the American Ceramic Society, cooperated in the development of the technical program. The papers presented were as follows:

Recent Developments in the Glass Industry—E. W. Tillotson, The Mellon Institute, Pittsburgh, Pa.

Glass Fibres—Games Slayter, The Owens-Illinois Glass Co., Newark, Ohio.

Laminated Glass—J. Hervey Sherts, Pittsburgh Plate Glass Co., Creighton, Pa.

These papers are of broad general interest to engineers and technologists and accordingly are given in full in the pages which follow.

Paper on Rubber Technology Progress, at Detroit Meeting on April 7

The Detroit District Committee is sponsoring a meeting to be held at the Fort Shelby Hotel, Detroit, on Wednesday evening, April 7, at which Dr. W. A. Gibbons, Director of Research and Head of the Development Department, United States Rubber Products, Inc., will present a paper on "Recent Progress in Rubber Technology." Doctor Gibbons has taken part in many important developments in the industry—he is the inventor of various processes for manufacturing rubber goods from latex, vulcanization of rubber, aeronautical materials, etc., and his paper will be a most interesting one.

President A. C. Fieldner, Chief, Technologic Branch, United States Bureau of Mines, is scheduled to speak on the subject, stories of the Bureau of Mines in the field of materials supply, and H. T. Woolson, President of the Society of Automotive Engineers, and Executive Engineer of the Chrysler Corporation, will also speak. C. L. Warwick, Secretary-Treasurer, will give a brief talk on the work of A.S.T.M.

The meeting will consist of a dinner beginning at 6.30 p. m. with the speakers' program scheduled to begin at 7.30 o'clock. W. H. Graves, chairman of the Detroit District Committee, will introduce the toastmaster for the evening, Harvey Campbell, Secretary of the Detroit Board of Commerce.

The development of the meeting program is being handled by T. A. Boyd, General Motors Corp., chairman of the Detroit Program Committee, while W. H. Graves, Packard Motor Car. Co., chairman of the District Committee, and C. H. Fellows, The Detroit Edison Co., secretary, are in charge of general arrangements for the dinner and meeting. W. C. Du Comb is handling the invitations and publicity for the meeting.

All members of the Society in the Detroit District and their associates and friends are invited to attend.

Recent Advances in the Glass Industry[1]

by E. Ward Tillotson[2]

It was just 100 years ago that a research-minded chemical philosopher wrote the following words:

> "The Arts of Life supply instances of periods when the Genius of Invention has been scarcely manifested; and others, when its progress has had accelerated velocity; among which latter the present seems most interesting because of the amazing variety and extent of improvements presented to the eye of the intelligent observer."

It was also during that era that one of the significant inventions in glass technology was made. At the Sandwich Glass Co. in Massachusetts a tumbler was made by pressing the molten glass into a mold. Prior to that time most glass articles, particularly containers, were made by forming on the blow-pipe, using such compressed air as human lungs could furnish, and depending largely on manual dexterity in accomplishing the shape and size of the final object. However, the hand-operated press with iron molds gradually was developed, and the way was opened for other advancements that were necessary before the present-day technology could be attained.

The other developments were not confined to the glass industry. The expansion of iron and steel manufacture, the application of electrical power, the introduction of new chemical processes which provided more suitable raw materials, and a better understanding of the chemical and physical characteristics of glass have all entered into making possible the glass industry of today. It is interesting to observe that most of what may be considered as recent advances had their origin during the years of about 1870 to 1890, an era of economic development and expansion in many industries, as well as in science and technology. For the purposes of this discussion, therefore, the period covered will be limited to the past fifty years.

[1] Presented at a meeting sponsored by the A.S.T.M. Pittsburgh District Committee, Pittsburgh, Pa., Feb. 25, 1937.

[2] Assistant Director, Mellon Institute of Industrial Research, Pittsburgh, Pa.

In 1880 the glass industry of this country had an invested capital of a little less than $20,000,000, and produced products valued at a little over $21,000,000. These products consisted of window glass valued at about $5,000,000, bottles valued at $5,670,000, and other glassware, largely tableware, worth about $10,000,000. At that time plate glass had not yet been manufactured profitably in this country, window glass was blown by hand, and bottles were those of the pharmacy and of the wine and hard liquor variety. The many other glass articles with which we are familiar—the glass fruit jar, the beverage bottle, wire glass, "safety glass," glass fibers, glass tile and building blocks, glass for directing illumination, and glass cooking ware—were for the future to develop. In contrast, such figures as are available indicate that the present annual production is valued at about $300,000,000.

GENERAL ADVANCES

Such a vast expansion in the industry could only be possible as a result of technological development, and could only be justified by the discovery of characteristics of glass which make its use not only practicable but also advantageous. It is not unreasonable to consider that before the recent epoch glass had served chiefly as a decoration and as a luxury, but that now it has attained a more vital station in our civilization and is taking its place truly as an engineering material.

During this expansion a multitude of specialized inventions have been made, the results of which have divided the glass industry into a variety of technologies with little resemblance to each other. In the early American glass factories window glass and bottles might have been made from the same pot of glass, and perhaps other articles also, but now the specialization is so great that, for example, a window glass plant may produce only one type of window glass. But there are a few basic advances that are of common significance. About 1879, the first continuous melting tank was built for making window glass. This consisted of a large open hearth in which the batch was introduced at one end and the melted glass was withdrawn at the other. This device has proved so successful that it has almost entirely supplanted pot melting, except for special glasses melted in small quantities. Such continuous furnaces may produce 400 tons of melted glass per day, and therefore furnish the constant supply of glass necessary for the mechanical drawing, pressing, rolling or blowing operations employed in the forming processes.

Such mass production of glass, however, was furthered by parallel improvements in chemical manufacture. The introduction of the Solvay process for the production of sodium carbonate provided a glass-making raw material of greater purity than had heretofore been available. As a result, it became possible to manufacture fine colorless glassware from soda-lime glass instead of being limited to the potash-lead compositions that alone were suitable for the higher grades of glassware, and it may be mentioned that the great bulk of glassware is now of the soda-lime-silica composition. Lead oxide and potash are employed only in some of the optical glasses and in certain varieties of tableware.

Among later developments should be mentioned improvements in the preparation of sand for glass making. Within the past ten years melting sand has been available in quantity containing as little as 0.02 per cent of iron, the most feared impurity, and with a total of color producing impurities of less than 0.1 per cent. Thus, two of the most necessary raw materials, constituting over 85 per cent of the glass substance, are now available in a state of purity comparable with that of laboratory reagents. Similar improvements, however, have not been made in the limestone used, nor has the refractories problem been solved satisfactorily. The refractories that come in contact with the molten glass dissolve slowly and contribute materially to the impurities introduced into the glass. Some progress is being made both in the direction of utilizing purer materials for refractories and in discovering synthetic compositions that dissolve in the glass more slowly. A refractory quite insoluble in molten glass would not only be of great economic advantage but would also make possible the production of superior glassware.

The discovery of natural gas contributed much to the expansion of the glass industry. It was cheap, and it taught the glass manufacturer the usefulness of gaseous fuel and stimulated the development of furnaces built for more economic utilization and application of the necessary heat energy. In recent years great improvements in furnace design have been made, as a result of which the output of a furnace, per unit of melting area, is several times as great as formerly. The use of gaseous fuels, in the light of a better understanding of the annealing process, has also revolutionized this necessary operation. Annealing now is universally conducted in continuous leers with temperature control of a most precise order. Electrical heating of annealing leers has been used successfully where costs permit, but the melting of glass by electric power is for the future to develop.

PROGRESS IN SPECIAL FIELDS

The foregoing represent developments of common interest, but there are many others of importance to the specialized branches of the industry. In window glass manufacture the first successful departure from the hand-blown cylinders was the process of drawing mechanically cylinders of far greater dimensions directly from the pot of glass. This process, invented in 1900, reached a high degree of development within fifteen years, and then within another fifteen years had been discarded for more efficient methods. At present, several processes are in use in which a flat sheet of glass is drawn directly from the surface of a pool of molten glass, and is passed continuously through the annealing leer. Such processes produce a sheet of greater uniformity and eliminate the not uncommon surface defects that were produced during the flattening of the cylinders.

Plate glass manufacture has also experienced fundamental changes, and these have taken place for the most part during the past fifteen years. Mechanization constitutes a large part of these innovations; plate glass, instead of being melted in pots, cast on tables, and in general being produced and handled in small units, is now largely melted in continuous tanks, from which it flows between rollers in a more or less continuous ribbon, and through the annealing operation. Then, after being cut in large sheets, which are mounted on veritable railway cars, it is carried in a straight line route beneath successive grinding and polishing heads, after which it is cut to the desired sizes. From the mechanical point of view these processes are developed to a high degree, and each of the steps contains a fascinating technical story that cannot be enlarged upon here. It should be mentioned that special plate glasses, such as the colored and opaque varieties and

some glasses for optical use, as well as ordinary plate glass of the larger sizes, are still melted in pots and cast on tables as in the former practice. This is, of course, because of the limited production requirements.

The manufacture of glass containers early received mechanical attention. The main problem in this case resided in controlling and subdividing a stream of glass, flowing from a tank, into properly sized charges. The designing of an automatic machine to receive these charges, perform the necessary pressing and blowing operations, deliver the finished articles to a conveyor, which arranges them neatly in the continuous leer, was a less difficult if not a less important development. Several different types of "feeders" and a variety of forming "machines" are in use; in general, each has characteristics that adapt it to some specific use.

One invention in bottle manufacture is worthy of mention. The use of glass containers for food products disclosed the problem of the "closure." It is obvious that if a tight seal is to be made, the opening of the container must be not only smooth but also must be accurate in dimensions. This was made possible by an invention in 1882, commonly known as the "prepressed blank." It consisted of pressing the "neck and ring" of the container in an iron mold, thus fixing its dimensions, and then transferring the mass of glass to the "blow mold" and completing the operation by blowing. This general principle is incorporated in all machine production of blown containers.

The development of automatic manufacture of electric light bulbs constitutes a record of most unique invention. The problems are not those of making the ordinary container, since the wall is much thinner and the surface must be smooth and free from any mold markings. In the most recent machine, developed within the past ten years, earlier methods have been discarded and a truly straight line continuous series of operations has been evolved. The molten glass flows from the tank in a continuous stream between rollers which form a glass ribbon, studded with thicker lens-shaped masses of glass. A series of molds and blowing heads approach this ribbon, perform their operations, and then recede, after which the bulbs are detached from the ribbon and proceed to the annealing operation. This machine is adaptable to making all but the larger sizes of bulbs and is capable of producing bulbs at an enormous rate.

INFLUENCE OF CHEMISTRY AND PHYSICS

The story of the mechanical developments in glass making is, however, only one phase of the general advance of the industry. Knowledge from the realms of physics and chemistry has also had its application, not only in guiding mechanical progress but also in the production of new products and in discovering new uses for glass.

The characteristics which make glass useful are its transparency, its susceptibility to coloration, its relative ease of shaping and molding, its inertness to water and other liquids, and its mechanical strength and hardness. The systematic chemical and physical studies of glass had their origin in the late 1880's, in Germany. The immediate consequence of these studies was the vast improvement in optical systems of all kinds. This research also laid the groundwork for the remarkable lenses now available for photographic and microscopic instruments. The investigations were concerned not only with glasses that transmit and direct the maximum amount of light, but also with those that transmit or absorb specific regions of the spectrum. Thus, effective colored glasses for signaling as well as those for goggles, where infrared or ultraviolet radiation is to be absorbed, are of recent origin. On the other hand, glass is now available which is opaque to visible light but which transmits ultraviolet to a high degree, and opaque glass is also made having a high transmission in the infrared. Of more general interest, perhaps, is the fact that sheet glass of high absorption for thermal radiation is finding favor for skylights and windows, particularly in industrial buildings.

The present-day efficient diffusing glassware employed in artificial lighting units is also a product of applied chemistry and physics and really deserves more than a passing mention. These glasses are essentially vitreous emulsions, in which two or more insoluble phases are present, and to that extent are analogous to the better-known water-and-oil emulsions.

The popular conception that glass is totally insoluble in water and that its surface is inherently stable towards its environment is unfortunately incorrect. The need for more chemically resistant laboratory ware, the clouding of the glass of spirit levels, and the severe service of steam gage glasses have inspired investigations productive of considerable improvements; these studies have thrown much light on the behavior of glass towards water. It appears that glass does not dissolve in water in the way that ordinary salts do, but some of the constituents seem to be hydrolysed, and the soluble products so formed, chiefly alkalis, are leached out. This action is relatively slow but is continuous, and may result in the roughening, as well as clouding, of the glass surface.

It will be recognized that this is of much importance, particularly in containers for pharmaceutical chemicals and for food products. Although much improvement in this respect has been made in recent years, the situation is far from satisfactory. Problems relating to glass surfaces are among the most important now engaging the attention of the glass technologist.

NEW USES FOR GLASS

Very recently, public attention has been directed to several new uses for glass, which indicate that this material is to have a larger place in building construction and as an engineering commodity. It is interesting to observe, however, that some of these new products are the ripening fruit of seeds planted many years ago. New mechanical devices and new appreciation of basic scientific principles have made practicable the production of these new products. For example, tempered glass, which was experimented with as early as 1875, has recently become a commercial product in this country. It is characterized by being in a highly strained condition, just the opposite of being well annealed, and as a consequence is strong and elastic, and possesses a much harder and less easily scratched surface than annealed glass. When breakage occurs, however, the entire piece breaks into a myriad of small grains. It has been in use, however, to a limited extent for many years, particularly for port hole glass in ocean-going vessels.

Spun glass has been known for many years and, in fact, a dress woven of this material was exhibited at the Columbian Exposition in Chicago in 1892, but until recently it has not been possible to make glass fibers of useful characteristics.

Because of the effectiveness of fibrous glass as thermal insulation it is interesting to make note of another product that is in process of development as an insulating structural material. It consists of glass which has been expanded into a spongy mass by the introduction of many small bubbles, in other words, a glass foam. This product is still in the development stage, but it illustrates the versatility of glass.

Glass building blocks and glass tiles are another new application of glass which are to be considered as being still in the development stage. Methods of manufacture are not yet entirely perfected, and the most suitable method of application is not wholly developed, but it seems inevitable that these forms of constructional glass will be found to satisfy, uniquely, certain needs in the building industry.

The sealing of glass to metal has been a problem of importance in the making of certain electrical appliances, and it is mentioned here because the present-day solution of the problem depends upon a peculiar characteristic of glass that was discovered during the past few years. It appears that some of the physical properties of glass depend upon its thermal history. For example, if two specimens of the same glass are subjected to certain different thermal cycles, and brought again to room temperature in perfectly annealed condition, it is found that certain physical properties of the two specimens are slightly different. While this phenomenon is perhaps not wholly understood, the knowledge of it has made possible the production of glass to metal seals that are substantially free from strain, and therefore less liable to breakage from this cause.

It would be an oversight if mention were not made here of the fabrication of large masses of glass. The recent casting of large disks of glass for astronomical telescopes is so well known that a detailed description will not be given here, but it is an achievement that has called for the last element of chemical and physical knowledge to accomplish successfully. It is difficult to imagine a disk of glass seventeen feet in diameter and a foot thick being formed without substantial flaw, and being cooled to room temperature without cracking and without optical strain. Although such a disk is employed as a structure for supporting a reflecting mirror, and not for transmitting light, glass appears to be uniquely suited for the purpose. Low thermal expansion, homogeneous structure, the ease of shaping to the desired curve, and the general permanence of dimension are advantages that glass possesses for this use.

The glass industry has long enjoyed almost a monopoly in certain uses for its products and it is not to be expected that such a condition could be a permanent one. Other chemical industries are now producing synthetic resins, sometimes called "organic glasses," which possess certain properties in common with glass, and which may be expected to serve certain purposes to advantage. At present, they suffer from being more costly than glass and are more easily scratched, and while it is difficut to visualize an organic material that would equal glass in this respect, these synthetic compositions are not to be overlooked as factors in the glass industry of the future.

In the foregoing discussion the attempt has been made to set forth some of the more important of the many advancements in the glass industry. Much of this advance has proceeded along mechanical lines, but the chemist and physicist have also had an important part, not only in the designing of new glass compositions and products, but also in the control of the product and of the materials that go into the glass compositions. As in some other industries the trend in glass making is towards the use of the purest raw materials for the batch, and, in this way, exercising high control over the composition. The usage requirements of glass products, both in chemical behavior and in physical characteristics, are becoming recognized and more correctly understood, and a systematic study of these problems is, indeed, under way. This meeting is therefore particularly appropriate and timely, and it may be expected that the results of such cooperative efforts will bring about still greater advancements in glass making.

Laminated Glass[1]

by J. Hervey Sherts[2]

LAMINATED GLASS is a type of safety glass in which two plates of glass are composited with a thin sheet of transparent plastic between them.

The object of such a combination is a transparent shatter-resisting article suitable for windshields of automobiles and the like. As such the outside plates must necessarily be very resistant to abrasion, wind pressure, and the elements; its inside member—the plastic—must be strong, tough, and elastic at all atmospheric temperatures; also it must be shear-resisting, and capable of being securely and permanently adhered to the glass. The function of the plastic is to absorb, without separating from the glass or rupturing, forces either from without or within, after they have broken the glass plates. In doing so the plastic sheet tends to prevent shattering to pieces, of the composite plate. It is for this reason that laminated glass of this type has come to be generally called "Safety Glass."

HISTORY AND APPLICATIONS

The history of safety glass dates back to 1905, at which time J. C. Wood, of England, discovered that two plates of glass with a thin sheet of celluloid or other plastic cemented between them, produced a composite plate which tended to remain intact when cracked. He applied for British patents on the idea in May, 1905, and the patent was issued in December, 1905. A corresponding U. S. patent was granted him in September, 1906.

Relatively little was done with laminated glass until the World War, at which time it found a commercial application in the form of gas mask lenses—many hundreds of thousands being used for that purpose. Its use in automobiles was very limited for a number of years, but after the War gradually increased until 1927, when it was adopted as standard windshield equipment by the Ford Motor Co. of America. Other

[1] Presented at a meeting sponsored by the A.S.T.M. Pittsburgh District Committee, Pittsburgh, Pa., Feb. 25, 1937.

[2] Superintendent, Duplate Plant, Pittsburgh Plate Glass Co., Creighton, Pa.

automobile companies rapidly followed in adopting it. By 1934 it was standard equipment for virtually all automobiles. It is estimated that in the year 1936 approximately 75,000,000 sq. ft. of laminated glass was used by the automobile trade.

Other applications are railroad, bus, and aeroplane windows; showcases and numerous specialties. A modified form of laminated glass in which additional layers of plastic and heavy glass are used is known as "Bulletproof" or "Multiplate" glass. In this form it is made to withstand all types of small firearms, including the 30.06 caliber United States army rifle.

MANUFACTURE

The manufacture of laminated safety glass is confined to two processes. First and principally, the plastic sheet process—whereby a previously made sheet of plastic approximately 0.025 of an inch thick is placed, as such, between two cement coated plates of glass. The assembly is adhered together by first passing it through heated rolls which forces the air from between the glass and plastic and causes them to adhere solidly and rigidly around the edge, the central areas being only partially adhered. The reason for not completing the pressing in this preliminary pressing operation is that it sets up edge strains which results in frequent cracking and edge separation of the final product. Preliminary pressing is followed by a final pressing operation in which the plates are submerged in a liquid in large autoclaves and subjected to a pressure of approximately 180 lb. per sq. in. and a temperature of approximately 240 to 300 F., depending on the type of plastic.

The second process of manufacturing laminated glass is the "Flow-On" process. By it, the plastic in the form of a lacquer is flowed on the surface of the plates of glass. After proper drying two of the coated plates are wetted with a solvent and placed together with the coated surfaces contacting each other. The assembly is then pressed in such a manner as to cause the plastic sheets to join and form a single sheet between the two plates of glass.

In principle, laminating of safety glass is quite simple. In practice, however, in order to effect necessary economies, a considerable amount of chemical research and development work had to be done. There are at present approximately 1000 U. S. patents in the safety glass field. They cover many processes and types of equipment; many products, having varying characteristics; modifying glass formulæ; glass treatments, and finishes; many types of adhesives; and almost unlimited plastics and modifications of them.

RESEARCH

From a research standpoint, except for minor improvements in the properties of laminated safety glass, it was necessary to concentrate principally on new and improved plastic layers, since glass does not, at least at present, lend itself to practical modifications which would greatly affect the final product.

Cellulose nitrate, plasticized with camphor, was the original plastic used by Mr. Wood and is still being used for about 25 per cent of laminated glass produced in the United States. The successful use of cellulose nitrate plastic, generally called "Celluloid" or "Pyralin," requires the use of a green-tinted or other actinic ray absorbing glass. This is due to the fact that cellulose nitrate plastics have a tendency to decompose when exposed to solar rays of less than 3650 Ångstrom units. Decomposition of cellulose nitrate plastics in the form of brown discolored and bubbled laminated glass have doubtless been observed by all, because large quantities were used during 1928 and 1929, before a satisfactory protecting glass was developed.

In 1931, cellulose acetate plasticized with diethyl and dimethyl phthalate, was adopted in large scale production, principally because it is very much more stable to sunlight than cellulose nitrate plastic. Its use immediately eliminated the difficulty of discoloration and bubbling and obviated the necessity of a special glass.

Acrylate resins plasticized with dibutyl phthalate are also being used in laminated glass. They are being used in the "Flow-On" process previously mentioned. They are very clear, resistant to water penetration and practically unaffected by the short solar rays. Perhaps the outstanding difference between the acrylate plastic and the cellulose nitrate and acetate plastics is its great stretchability. This property contributes to laminated glass what is known as a yielding break or stretching rather than a drum-head break.

Each of the three plastics mentioned above imparts certain desirable characteristics to safety glass, but all have the common weakness of tending to become more or less brittle at low atmospheric temperatures, in the neighborhood of 0 F. To be more specific they are only one-fifth to one-tenth as resistant to break tests at 0 F. as they are at 70 F. However, it might be well to state at this point that in spite of their loss of strength at low temperatures they still resist breakage to a marked degree over ordinary glass.

Safety glass research departments have long recognized this "short cold tendency" as one of their major problems. Most of their work during the last five years, therefore, was done in an effort to develop a plastic which would not fail in this respect. As a result, the Duplate Research Laboratory recently succeeded in developing a new plastic sheet, by compounding a special vinyl acetal resin with a glycol hexoate plasticizer. Both the resin and plasticizer are products of research on the part of the Union Carbide and Carbon Chemicals Corporation's Fellowship at Mellon Institute, which cooperated closely with the Duplate Laboratory in a joint effort to solve the problem. The new resin plastic sheet has been given the commercial name of "Vinal" from the words "Vinyl" and "Acetal" and the laminated glass in which it is used is called "Hi-Test" because of its superior properties.

"Hi-Test" safety glass withstands the half-pound steel ball test approximately ten times as great as nitrate and acetate types of safety glass at 0 F.; approximately four times as great at 70 F.; and approximately two times as great at 120 F. In other words, 12 by 12-in. "Hi-Test" samples withstand the blow of a one-half-pound steel ball dropped approximately 40 ft. at 0 F.; 80 ft. at 70 F.; and 40 ft. at 120 F. Other very important properties of the Vinal plastic is its very great elasticity, combined with high tensile strength. Its elasticity enables it to absorb a blow much the same as the acrylate resin, and its high tensile strength after stretching tends to prevent penetration or rupturing of the film. In this respect Vinal plastic resembles rubber. These properties are particularly important in the case of one's head or other part of the body forcefully striking a windshield or sidelight. Tests indicate that a windshield, when struck by

an object intended to represent one's body being thrown against it, first cracks and yields or bulges approximately four inches, after which, because of its high tensile strength, it tends to pull from the frame rather than break to pieces, or permit the body to force its way through it.

Editor's Note: After stating that he had "briefly covered the subject of laminated safety glass in a very general way," Mr. Sherts showed slow-motion pictures of some tests on several kinds of safety glass, including a type which is not laminated. He concluded his paper with the following remarks on this tempered safety glass.

Tempered safety glass or "Herculite," as it is trademarked by our company, is simply a case-hardened glass. Tempered or case-hardened safety glass is ordinary glass which has been uniformly heated to approximately 1100 F. and then quickly chilled by jets of air. This treatment tends to set up balanced strains in the glass—the surface being under compression and the interior under tension. For this reason tempered glass is approximately five to seven times as strong as the same piece of glass before tempering. When it is cracked, thereby releasing the strains, it tends to break into small granular particles approximating $\frac{3}{16}$ in. in cross-sections, instead of large pieces. One unusual property of tempered glass is that it cannot be cut to pattern sizes and shapes, or successfully edged after tempering.

Glass Fibers[1]

by Games Slayter[2]

We are speaking of nothing essentially new when we talk about glass fibers. As glass is a fluid at high temperatures, fibers are readily drawn from any molten glass. Many of the oldest known historical relics are made from glass. They have survived because of chemical stability, resistance to acid attack, wetting and drying, decay and rot. It is the permanence of glass which makes glass fibers so interesting from many viewpoints. As a matter of fact, glass fibers have been put to special uses for several centuries, and since 1904 they have taken their place in the industrial world.

However, it has been but recently that glass fiber has been available in sufficient quantity, of uniform quality, and of low enough price to be of interest commercially for any purpose. At the present time it is being used principally as an insulating material; here again the inherent stability of glass plays a great part in its value.

During the World War a method for the commercial production of glass fiber for insulation purposes was developed in Germany, where the supply of asbestos had been cut off by blockades. Of course, the first way in which glass fibers were made was to heat a rod in a gas flame and pull the molten tip to arm's length. The slow, tedious process made it impractical commercially. Then a method was developed where the initial drawing was started by hand and the thread was thrown around a bicycle wheel which the operator pedalled as fast as possible. A package of fibers was built up to the size of a tire and cut off. The capacity of this process was increased by heating several rods simultaneously and winding the filaments on a number of wheels.

FIBERGLAS AND TENSILE STRENGTH

This was the state of the development of the art when our company's process was developed in 1931. During the last year and a half, by arrangement with the Corning Glass Works, the research on glass fiber products is being carried on jointly. Owens-Illinois Fiberglas is made by American mass production methods, thus permitting economical production. The process consists in allowing the molten glass to pass through a number of very fine holes, the resultant streams being drawn into fibers by steam. In the production of insulating materials these filaments, falling on a conveyor belt, build up a mat of Fiberglas about seven inches thick. This is compressed to four inches before being cut and trimmed to proper size. While glass weighs, roughly, 150 lb. per cu. ft., the Fiberglas mat weighs only 1.5 lb. per cu. ft. Thus, in fabricating the glass, 99 per cent air has been entrapped.

It has been known for years that glass, if drawn sufficiently fine, becomes flexible, and when the fiber diameters are sufficiently small, can even be tied into knots, particularly where the fibers are in the form of yarn. This is true because the radius of curvature is not so small in the yarn as when a single fiber is bent. The relationship between fiber diameter and the size of the loop which can be made in the fiber is approximately quadratic; that is, by halving the diameter, the loop size is reduced to approximately one-fourth its original size. In addition to flexibility, tensile strength improves as fiber diameter is reduced, the relationship again being apparently quadratic. The typical strength of glass in rods is about 20,000 lb. per sq. in., while strengths in commercially produced fibers have gone as high as 2,000,000 lb. per sq. in.

Glass fibers used in heat insulation materials are quite long, the average length being well over 30 in. It is difficult to determine exactly the length of one fiber because of the intertwining which occurs as the fibers felt up on the conveyor. Depending on the product being manufactured, the fibers vary in diameter from 0.02 in. to 0.0002 in., while some fibers for special purposes have been produced as fine as 0.00005 in. The individual strength of these fibers is astounding, averaging 250,000 lb. per sq. in. for the grades which have diameters of about 0.00035 in. Theoretically, the maximum upper limit of glass strength, including both the lattice and vanderwalls energies, is 12,000,000 to 14,000,000 lb. per sq. in. In several experimental tests, with fibers of 2 micron diameter (0.00005 in.), strengths of 3,500,000 lb. have been reached, or 25 per cent of the maximum theoretical strength.

It is unnecessary to go into the classical theoretical work that has been done on tensile strength of materials, but it is well known that the low strengths of metals, and the brittleness of glass are attributed, respectively, to slippage planes and incipient cracks, or discontinuities, in the material. In

[1] Presented at a meeting sponsored by the A. S. T. M. Pittsburgh District Committee, Pittsburgh, Pa., Feb. 25, 1937.

[2] Director of Research and Development, Industrial and Structural Products Div., Owens-Illinois Glass Co., Newark, Ohio.

glass these discontinuities are obviously most dangerous at the surface, because any tensile load is then concentrated on a very small area, and extremely high stresses arise at the inner end of the discontinuity. Since tensile strength tests taken on fibers which have just been formed show appreciably higher strengths than those on fibers which have stood for some time, it has been suggested that a rearrangement of molecules takes place with the resultant formation of discontinuities which contribute to the loss in strength. Another theory postulates that the gas above the melt is entrapped during the drawing of fibers and, as cooling takes place, is collected in "pockets" and aids in the formation of discontinuities.

THERMAL INSULATION

But, just why is the tensile strength so important and how does it enter into the performance of Fiberglas insulation? In two ways. Wherever glass fiber is to be used as an insulating material it is supplied to the job in thicknesses greater than that of the space which it is to fill. The high tensile strength of the fibers tends to make the pack fluff out and guarantees that the insulated space will be filled with material. This reduces convection to a minimum and still allows for the slight amount of air travel required to remove any moisture which may condense in the insulation. Moisture is one of the most deadly enemies of insulation. This has been illustrated by installations of vegetable, mineral, and animal insulations which, too tightly packed, absorbed moisture and became thoroughly dampened, and then could not give up this moisture because all convection was stopped through the material. This led to rot, decay, and destruction of the fibers of the insulation. Also, if any vibration is encountered, the Fiberglas tends to fluff out further rather than to settle.

It is reasonable to inquire just what efficiencies can be expected from Fiberglas insulation. Normally, thermal insulation efficiency is expressed in terms of conductivity—the B. t. u. loss through one inch of material, per deg. Fahr. of temperature difference, per hour. Under normal operating conditions, where the mean temperature is approximately 70 F., Fiberglas insulation has a conductivity value of 0.25 B. t. u. per hour. To obtain this conductivity at higher temperatures, a slightly higher density is required, while, in refrigeration work, the conductivity is, naturally, lower. Fiberglas is used in the range from 1.5 to 4.5 lb. per cu. ft., the density having been determined for optimum operation under any given temperature range.

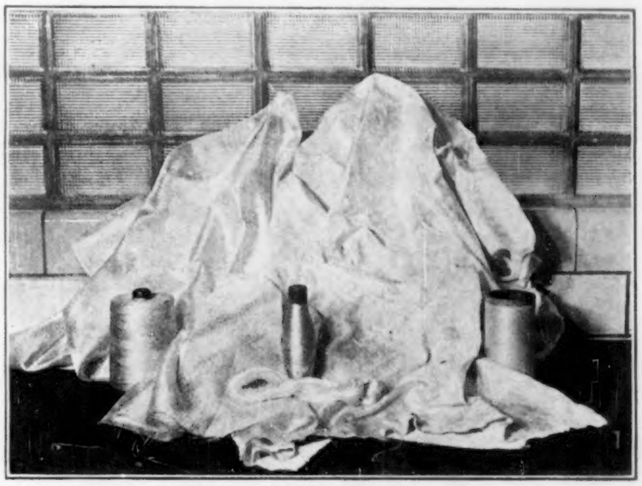
Fiberglas is a very light insulation material. A floor area of 800 sq. ft. can be covered four inches thick with 400 lb. of Fiberglas insulation. Thus this material only adds $\frac{1}{2}$ lb. per sq. ft. to the floor construction. This slight increase in weight is negligible.

Fiberglas has another advantage. It is a definite fire-retardant. It will withstand temperatures of 1000 F. without fusing and tends to smother any flames with which it comes in contact. It is also definitely a dielectric, that is, if a wire breaks and an arc forms, the Fiberglas will insulate combustible material from the arc.

TEXTILES

The insulation value of glass fiber is by no means the only application of Fiberglas, although it is the most widely known. At the present time Owens-Illinois is, and has been for several years, experimentally producing textiles from this same glass fiber. Thread has been made from filaments which are tremendously long—made specifically for textile usage, and for that reason processed in slightly different manner than the insulating fiber. We call these textile materials "continuous filament material," as fibers have been drawn without a break to the length of 5040 mi. Sixty of these continuous filaments are placed together to form a strand, corresponding in the silk or rayon system to 75 denier.

Here again, tensile strength and flexibility play a big part. The tensile strength of these individual filaments is 250,000 lb. per sq. in., while the tensile strength of the 60 filament strand, on the basis of the diameter of the strand, is 17,000 lb. per sq. in. However, when the tensile strength is calculated, not on the diameter of the strand, but on the aggregate of the individual filaments themselves, the strength is 247,000 lb. per sq. in.—a good check.



Fiberglas Yarns and Fabrics

Just as in other textile operations, a sizing is used until fabrication is complete, and then it is washed off, leaving the pure glass, incombustible, impervious to chemical attack, and incapable of absorbing moisture.

But it is not necessary to use these continuous filaments exclusively for textile purposes. Staple length material is also widely used in our textile operations, some of the finest cloths being made from staple length yarn.

ELECTRICAL INSULATION

The strengths of Fiberglas textiles are much greater than those of competing products. For instance, in the case of tapes for electrical insulation, high-temperature purposes, Fiberglas tapes have a tensile strength of 250 lb., whereas other insulations average 50 lb. for a tape of the same dimensions. This is important in the winding of motors, and similar usages. Our yarns compare very favorably in strength with cotton and wool yarns of similar size.

In addition to tapes, Fiberglas can be used also in the form of very fine yarn to wind individual small wires. Either of these forms has a very high dielectric strength, being on the order of 125 v. per mil on unimpregnated tapes. For impregnated tapes the average is 1200 v. per mil. It requires but half the thickness of glass tape to supply the same insulation that is given by other tapes—for instance, a

0.015-in. glass tape has a higher dielectric strength than similar high temperature insulations 0.025 in. thick. When an impregnation treatment is used, the same holds true—one-half the thickness of glass is required. The tape is readily handled, presenting no problems in installation.

The yarn form is used in insulating wires and cables and is wound on the wires by machines which have been used for this purpose for years. If an impregnation treatment is desired, it is given either during or after winding the yarn on, just as is done with any other textile material.

Two great advantages of glass are readily apparent; first, it is fireproof and is unaffected by high temperatures; second, it is permanent. It is not affected by moisture, will not rot, decay or age. The temperature at which a machine, such as a motor, can be run with glass insulation is limited only by the impregnating material used with the glass.

FILTERING MEDIA

The chemical stability of glass has been mentioned. It plays an important part in another application of Fiberglas—as a woven filtering media. The textile yarns mentioned previously are woven into a tight cloth on existing textile machinery, and the cloth is placed in operation under severe filtering conditions. Tests have been run on samples under acid conditions where the life of wool filter cloth averages 10 days. Fiberglass filter cloth operated satisfactorily for 40 days. Of course, it is readily applied to neutral filtrations. As yet it is not being made for use under alkaline conditions.

It is in filtration that the surface condition of the glass fiber shows its importance. Where an ordinary glass bottle has 90 sq. in. of exposed surface, a fine fiber, weighing as much as a bottle, has 8,740,000 sq. in. exposed. If it were not for the stable characteristics of glass, any chemical attack would be ruinously fast on such an area.

However, the advantages of glass as a filtering media are not limited to its chemical stability and heat-resistance alone. A woven glass cloth requires only one-sixth the pressure necessary to obtain the same filtration production on a similar cloth of cotton. In addition, glass is sufficiently resilient to prevent packing of the fibers under high pressures and filtration efficiency is not changed through long life.

It is expected that, in the near future, Fiberglas fabrics will find widespread applications outside of the two fields specifically mentioned. Glass, inherently, has the very valuable characteristic of non-inflammability, which is found in all mineral, or inorganic, materials. Theater drapes, hotel tapestries, awnings, and a multitude of other applications are foreseen for glass textiles. Colors can be readily produced, although they are not being made in production as yet, since it is not serving a market where colors are essential.

Symposium on Wear of Metals in Philadelphia, April 5

At a meeting to be held at the Engineers' Club in Philadelphia on April 5, sponsored by the Philadelphia District Committee, under the chairmanship of H. M. Hancock of The Atlantic Refining Co., there is to be held what promises to be a most interesting Symposium on Wear of Metals. The six technical papers by prominent technologists in the respective fields will be presented in an afternoon and an evening session.

The technical program was developed by a special committee headed by Dr. G. H. Clamer of The Ajax Metal Co. It will be noted from the program which follows that the papers will deal with wear and wear tests in various fields where this problem is an important one. Because of the importance of this subject, the symposium should be of interest to many of the technologists in many industries where various problems in connection with wear and wear testing are significant.

Symposium on Wear of Metals

Afternoon Session—2.30 p.m.

Chairman.—Dr. G. H. Clamer, President and General Manager, The Ajax Metal Co., Philadelphia, Pa.

General Discussion and Considerations Involved in Wear Testing, Including the Classification of the Various Types of Wear—H. W. Gillett, Metallurgist, Battelle Memorial Institute.

Some Important Variables Encountered in Wear Tests on Cast Iron—D. E. Ackerman, Metallurgist, Research Laboratory, The International Nickel Co., Inc.

Wear from the Textile Industry Viewpoint—Albert Palmer, Crompton & Knowles Loom Works.

6 P.M. Dinner $1.00 per Cover

Evening Session—7.30 p.m.

Chairman.—Dr. A. C. Fieldner, President, A.S.T.M.; Chief, Technologic Branch, U. S. Bureau of Mines, Washington, D. C.

Wear of Metals from the Railroad Viewpoint—L. W. Wallace, Director, Equipment Research Div., Association of American Railroads.

Wear from the Automotive Viewpoint—W. E. Jominy, Metallurgical Dept., Research Laboratories Section, General Motors Corp.

Wear from the Power Equipment Viewpoint—N. L. Mochel, Metallurgical Engineer, Westinghouse Electric and Manufacturing Co.

It will be noted from the above program that a dinner is scheduled for six o'clock. The dinner will be held at the Engineers' Club and will be of an informal nature with no specific program.

Detailed notices of the meeting are being sent to each A.S.T.M. member in the Philadelphia District and local members of the Society of Automotive Engineers, American Society for Metals, The American Society of Mechanical Engineers, and other groups affiliated with the Engineers' Club are cordially invited to attend the technical sessions and be present at the dinner.

Consideration is being given to the possibility of publishing or duplicating the papers and further announcements concerning this will be made.

Officers of the Philadelphia District Committee in addition to Mr. Hancock, chairman, are Alexander Foster, Jr., Warner Co., vice-chairman, and Harold Farmer, The Philadelphia Electric Co., secretary.

Successful Meeting in Cleveland

At a meeting at the Cleveland Club on Thursday, January 28, sponsored by the Cleveland District Committee and the Cleveland Section of the American Society of Mechanical Engineers, four papers were presented on the general subject of "Making of Specifications." A good attendance of A.S.T.M. members in the Cleveland District and the members of other local sections of various engineering and technical societies was noted. There were about 150 at the papers session and the dinner. The program was as follows:

Specifications in Industry—James H. Herron, President, The James H. Herron Co., and President, A.S.M.E.

Federal and Military Specifications—R. W. Pinger, Ordnance Officer, Cleveland District.

The Statistical Basis of Specifications—H. F. Dodge, Bell Telephone Laboratories, Inc.

The Genesis of an A.S.T.M. Specification—A. C. Fieldner, Chief, Technologic Branch, U. S. Bureau of Mines, and President, A.S.T.M.

Colonel Pinger, in discussing federal and military specifications, first outlined governmental needs and included in his discussion mention of the basic statute underlying federal purchasing, the development of the Federal Purchasing Board and Federal Specifications Board and finally the organization of the Procurement Division of the Treasury Department. He described the various matters of interest in connection with federal specifications and mentioned the differing requirements of some of the federal departments. He also covered some aspects of military specifications indicating as one of the primary requisites that they must above all things be usable during an emergency.

In his paper describing how A.S.T.M. develops specifications and tests, President Fieldner first outlined the A.S.T.M. organization and mentioned the competence and representative character of A.S.T.M. committees. He pointed out specific examples showing the development of a committee and mentioned the large number of fields covered in committee work.

By taking specific specifications his discussion of the procedure for developing an A.S.T.M. standard was made of particular interest. He covered as his first case a standard in the province of an existing standing committee and then covered an item not within the province of an existing committee and where the Society does not have a standing committee. He outlined the organization of new committees. In concluding he stated that "the founders of our Society used good judgment when they linked the promotion of knowledge of the properties of engineering materials with standardization. We believe that the application of such knowledge through permanent committees representing all interests concerned and composed of the various engineering professions leads to competent, unbiased and authoritative specifications.

The papers by Messrs. Herron and Dodge are reprinted in this Bulletin on the following pages.

Arrangements for this successful local meeting were carried out by H. A. Schwartz and A. J. Tuscany, chairman and secretary, respectively, of the Cleveland District Committee.

Specifications in Industry[1]

by James H. Herron[2]

In contemplation of the growth of human enterprise and the inception of social customs and practices, one's visualization inevitably leads back to the progenitor of the race as an individual entity. Likewise he sees the inception of mass thought and activities having their origin in single units of the human family.

As long as there was but one man his own ideas and concepts needed no modification and yielded to no influence outside of his own thoughts and feelings. His only adaptations were to his physical environment. When a second person entered his mental universe, there arose the necessity of exchange of ideas, giving origin to language, however crude it might be, but necessarily having the same validity and force between the two communicating parties. Thus arose in the evolution of the civilizing process the first instance of standardization. As the human family increased in numbers the necessity of further coordinating their social activities multiplied and a larger effort was made in family, tribe or clan to secure conformity to standards of action laid down in rules or laws promulgated by patriarch or chief, whereby these small social or political units were regulated. The number of these small units increased with the growth of the human family and, because of economic relations and intertribal trade and transportation, they became fused into larger political units under rulers, usually kings, who prescribed rules of action in laws instituted mainly by edicts. At any rate we see the first extensive efforts and effects of standardization in the laws which governed the subjects of the royal potentate in power on the throne.

Along with this growth of political developments, there is to be noted ever increasing convenience in transportation, travel and extension of merchandising and trading. The various guilds early recognized the importance of complete understanding between tradesmen, of terms of sale, of unit quantity and exchange values. From this necessity came the establishment of a code, regulating sale and barter, and units of weights and measures as well as a system of monetary values. Ultimately these agreements, originally extra-legal, became matters of concern to the constituted authorities of the states or nations, and became embodied in large measure in the established civil code of laws by legislative enactment.

Thus it is observed that standardization is as old as the race and has advanced as civilization developed, and new influences of a more complex life demanded a new set-up in human relations. With the advancement of scientific knowledge, the greater mastery of physical forces, the discovery and invention of means to mechanize human activity, the growth of easy and rapid transportation, the advent of the commer-

[1] Presented at a meeting jointly sponsored by the Cleveland A.S.T.M. District Committee and the Cleveland Section, A.S.M.E., Cleveland, Ohio, Jan. 28, 1937.

[2] President, The James H. Herron Co., Consulting Engineers, and President, The American Society of Mechanical Engineers.

cial and industrial age was upon us. We are now in what may be termed the mechanical era of social evolution. With it has come the imperative demand that standardization be recognized and applied in these fields of endeavor. Design and invention have their origin in individual effort, or in small groups of individuals at most. Manufacture and distribution involve a larger number of groups with a wider dissemination. The consumer of the products of designer and manufacturer constitutes the most widespread and numerous group concerned with industry. It is partly to his economic interest that standardization is a requisite and contributory factor.

SPECIFICATIONS

The last fifty years have seen the greatest developments along industrial lines. Prior to the beginning of the century, the character of standards was largely in the matter of form, but as production increased, interchangeability progressed and greater use was made of different devices and conditions, it became necessary to set a standard and define this in the form of a specification.

Early in the machine tool industry, the use of certain standards of form became necessary, such as tapers for milling machine, lathe and drilling machine spindles. Unfortunately these standards were developed by different manufacturers and were not interchangeable. Could some agency such as our societies, which have since developed a standard of machine tapers, then taken an active part in this work much grief could have been avoided.

When bicycle manufacture developed into automobile manufacture, standards of both form and quality became necessary. In these our technical societies have been participating; the A.S.M.E. in standards of form, the S.A.E. in standards of both form and quality, and the A.S.T.M. in standards of quality; the former mainly through the American Standards Association, and the latter mainly through their own established publications.

Standardization activities have now grown to such an extent that there is hardly a manufactured article which does not embody in its form or materials, standards which have originated in one of our technical societies; many Government specifications embody references to the work of these various societies.

When the development of electricity was in its infancy, almost every maker of any electrical equipment followed his own designs. Parts or appliances from any other source could not be combined with those of any other manufacturer. Perhaps many can recall the Edison socket which would take only an Edison bulb. Now, due to standardization, the universal standard socket of any make will take the bulb of any make. This has simplified matters for the consumer and extended the use of electricity.

STANDARD OF QUALITY

But these references have been only to standards of form or design. A comprehensive concept of standardization involves in no smaller measure the ideas of quality, performance and practice.

Standard of quality is now, in the eyes of the industrialist and the awakening consciousness of a consuming public, looming as of weighty importance more than in the past. "Caveat emptor," or let the buyer beware, is so firmly entrenched as to be accepted with legal force or recognition. What was sold was what was bought, provided no expressions of misrepresentation existed, and so it stood in law. "A pig in a poke" is another way of expressing the same idea. But by specifying and setting up standards of quality and performance, blind buying and trick selling are being relegated to the limbo of hated things.

The products of manufacture are the commodities offered to a buying and consuming public. These articles are bought to serve a preconceived use in the purchaser's economic welfare. How well they may serve that purpose depends upon the quality of material going into their construction and the care and attention bestowed in the manufacturing process. Scientific research and observation have so familiarized engineers with the properties and behavior of matter that it is now quite possible to predict and design structures of definite life and performance. In connection with this assurance of quality there has been of necessity a development of laboratory facilities where tests may be made and performance behavior may be observed under controlled conditions by men trained for the purpose and skilled in the application of their knowledge. The organization and equipment of such laboratories is rather expensive. Only some of the more wealthy industrial enterprises can afford to maintain such testing departments. However, the small industrialist is not barred from having these facilities as an adjunct to his industrial operations. There are privately owned commercial laboratories which will serve the occasional demand for a moderate fee, thus giving the benefit of quality measurement to any who may wish to avail themselves of it.

Practically the entire output of industry is now in process of standardization, some of it by individuals or companies, others by technical organizations, and still others by the Government. The varieties of quality to be measured and for which standards of quality are to be set is without limit.

Scarcely any trade, professional or technical organization in this country exists that does not have a committee to treat with standardization of some phase of the particular thing with which it has to deal. In many instances several groups are concerned with the same problem but in different aspects. Thus the human singing voice has its limitations set between two physical vibration frequencies. Instrument makers must set their standardization so that it conforms to this range and still be agreeable to the physical structure of the instrument. It is said that an increase of five vibrations per second in the standard *A* tone with a corresponding change throughout the entire scale would put an additional strain of about half a ton on the framework of a piano. A singer trained to an instrument of a certain pitch may suffer serious strain if required to perform at a slightly different pitch. The artist and instrument maker must work together to establish a satisfactory prominent standard.

Programs for standards are recognized and initiated in the textile design and manufacture industry, in the laundry and cleaning activities, coupled with the dyeing trade. All these demand cooperation and coordination.

IMPORTANCE OF STANDARDS

While the organizations represented here have been concerned with mechanical devices, it is quite apparent their pioneer efforts have exerted an influence in initiating similar

activity in every field of industry. We may be glad and perhaps assume a bit of pride that our societies have been foremost in promoting so momentous a movement. And as we have worked so harmoniously with our constituent but diversified groups, so can we give our moral support to those who have started a little more tardily toward the goal of achieving a greater good for a greater populace. Much experimental work must be done and many established standards must be revised. Standards of quality serve to promote improvement in output; they give bidders a chance to quote on the same basis of anticipated delivery quality; they equalize prices and afford a certain protection to the purchaser. They furnish a scientific basis for fair dealing, to avoid disputes and to settle differences. Standards of quality replace guesswork and rule-of-thumb estimate of values. They promote truthful branding and advertising by prescribing quality measurably. They are the latest phase of standardization and operate immeasurably to the benefit of both producer and consumer.

Formerly when each engineer or manufacturer had his own specification the situation was confusion worse confounded. With the advent of standards sponsored by the various technical societies has come great relief, with a common meeting ground for the buyer and seller. The speaker predicts that all buying agencies will, in a compartively short time, purchase only upon some well-known specification. To break away from the old haphazard custom and to recognize the benefits of standards of quality has been and is a laborious process, because of the inherent tendency of many producers and consumers to cling tenaciously to established customs and traditions. To promote the use of satisfactory standards by both interests, a relentless campaign of education must be carried on by such organizations as ours, and to this end great efforts should be directed.

Statistical Methods and Specifications of Quality[1]

by H. F. Dodge[2]

Much of our knowledge of new materials and methods of testing is contained in quantitative data, the results of measurements made in laboratory and factory. It is believed that a great deal can be accomplished in specification work by a still wider application of some of the simpler statistical methods to the quality data obtained in research, development and routine testing. The following statement by A. C. Fieldner seems appropriate: "The first step in the effective use of any material is the accumulation of knowledge concerning its properties and composition. The second step is the reduction of this unorganized knowledge to a science by proper classification."[3]

This discussion will refer principally to products involving repetitive operations, where the aim is to make the same thing over and over again. It is to such things that these methods are particularly applicable.

Two features of a specification are especially worthy of attention:

(1) The maximum and minimum limits specified for essential characteristics of a material or an article, and

(2) Sampling clauses laid down to define criteria of acceptance and rejection, applicable to test results for samples that are to be selected from shipments or lots of product.

Both involve questions of a statistical nature and some significance may be attached to the increasing recognition of standardizing bodies, both here and abroad, that such questions can advantageously be handled with the aid of statistical methods.

SPECIFICATIONS AS A MEANS TO AN END

A specification may be thought of, first of all, as a means to an end. A die-cast article is to be produced to perform a certain function in a machine, such as an automobile. When it goes into service, it must withstand certain stresses, resist corrosion, and show itself capable of resisting continued wear and the shocks imposed upon it by that service.

The Specification Committee has the task of selecting those characteristics of the finished article which, if controlled within certain limits at the time of manufacture, will give assurance that its performance as sensed in the future by the consumer will measure up to expectations. Just what items should be selected? What limitations should be imposed upon them? What acceptance requirements should be incorporated in sampling clauses? These questions can be answered best if there is available to the committee information as to how materials of various properties and composition will behave under different conditions and how closely the variations in these features can be controlled at reasonable cost under the normal operating conditions of a well-equipped plant.

A project recently carried on under the auspices of an A.S.T.M. committee furnishes a good example of proceeding in this way. With the active cooperation of several producers and testing laboratories, a comprehensive series of tests were conducted on some 21 aluminum-base and zinc-base die-casting alloys to provide information as to their physical properties and stability under indoor and outdoor conditions over a period of years. Tentative specifications of practical importance to industry today were written for several of the alloys in the light of these test results and the experience of several large-scale producers under quantity production conditions.

SETTING MINIMUM LIMITS IN A SPECIFICATION

In order to consider some of the questions that arise in setting minimum or maximum limits in a specification let us take a fragment of these data, and note some of the things that can be done by statistical methods that could not be done otherwise. The use of incomplete data for one quality characteristic will help to simplify the illustrations and yet provide material suitable for indicating procedures that are generally applicable.

Figure 1 shows the tensile strength results obtained by one of the testing laboratories on round test specimens of a zinc-base die-casting alloy. In initial tests as well as in each of three later tests made after shelf life aging, tensile strength

[1] Presented at a meeting sponsored by the Cleveland A.S.T.M. District Committee and the Cleveland Section, A.S.M.E., Cleveland, Ohio, Jan. 28, 1937.

[2] Bell Telephone Laboratories, Inc., New York City.

[3] A. C. Fieldner, "American Standard Sets Up Common Language for Coal," *Industrial Standardization*, November, 1936.

results were obtained on 25 test specimens, five from each of five producers. Each spot on the chart represents the observed tensile strength, in pounds per square inch, for a specimen.

This figure illustrates an ever-present and important characteristic of quality—its variability. Try as we may with the utmost refinements in manufacturing processes, two things cannot be made exactly alike. The values of tensile strength for specimens in any sample will not be found identical. The differences between observed values, while affected, to be sure, by errors of testing, reflect actual differences in the specimens themselves. If we were to tabulate the numerical values for a large batch of test specimens made by one producer under the same essential conditions, we might expect to find them distributed somewhat in the manner shown in Fig. 2. Statistically, the two most important measures of such a "frequency distribution" are the average, $\overline{X}$ (the simple arithmetic mean of the individual values), which indicates the central position of the values on the scale of measurement, and the standard deviation, σ (the root-mean-square deviation of the individual values from their average), which measures their spread around their average. Generally speaking, for frequency distributions having a fairly large number of observations, approximately two-thirds of the observations may be expected to fall within the range "average plus or minus the standard deviation, $(\overline{X} \pm \sigma)$," and practically all within the range "average plus or minus three times the standard deviation, $(\overline{X} \pm 3\sigma)$."

Let us take the data shown in Fig. 1 and compute the average and the standard deviation for each of the samples of five test specimens. These are plotted in Fig. 3 in the form of "quality control" charts,[4] a device developed by Shewhart, for the practical purpose of discovering the causes of non-uniformity in quality. The "control limits," shown as dotted lines, furnish a basis for interpretation and action by providing boundaries within which the averages and standard deviations of samples in a repeated series of events would be expected to fall under uniform conditions.

One might ask, what does this chart contribute that is not obvious in a chart that shows merely the averages? Referring to the four charts for averages, it will be noted that three out of four of the averages for Producer 4 are below the lower control limit and at the same time all four averages for Producer 5 are above the upper control limit. What may be concluded from this? Specifically, the charts allow us to say the following. The deviations shown for Producers 4 and 5 are not simply deviations due to sampling fluctuations. There is a definite cause for the low level shown by Producer 4 and a definite cause for the high level shown by Producer 5. Furthermore, in each case, *that cause is findable.*

This result can be shown somewhat more clearly perhaps by consolidating the data for the 4 series of tests. Figure 4 gives a composite chart in which the levels of each of the producers is shown relative to the composite average for all. Combining the four sets of charts into one appears justified statistically in view of certain consistencies shown by the data for the several suppliers.

It might be contended that anyone with a little common sense could see that Producer 4 was running low and that Producer 5 was running high. This is undoubtedly true. Could common sense say with assurance that there was a findable cause? Possibly so in this case. But suppose the lowness and highness of the levels of these two producers were only one-half or one-third as great as shown in Fig. 4, what then? Where is the dividing line? The control chart would continue as before either to say "Findable cause" or "Don't bother to look" with respect to the results of each producer. Common sense, even though supported by considerable experience in parallel problems, would in general have no precise basis of making this distinction.

Suppose the specimens used in these tests were representative of the regular run of product and that all producers had substantially the same degree of variability under quantity production conditions. The committee would be able to state to Producer 4, for example, that in some specific respect his process was different, that there was a definite cause which could be found, and that its correction would enable the committee to place the minimum limit some 2000 lb. per sq. in. higher. Whether or not it would be desirable to raise the limit is another matter. The aim should be to set the limit in the best interests of all concerned, compromising between what it is feasible to produce economically and what it is feasible to use economically, balancing the chances of rejecting product on the one hand against the chances of failure in service on the other. With the aid of control chart analysis, such compromises need not be made unwittingly. They may be made with the knowledge that if the limit were raised to meet the needs of service, this action would require either no adjustment or an adjustment of a definite kind in the process of a given producer.

SAMPLING CLAUSES IN A SPECIFICATION

Let us consider next one or two problems relating to the writing of sampling clauses in specifications. Tensile strength is typical of many characteristics for which there is no alternative to testing but a relatively small sample of the whole. If for such characteristics the specification is to lay down sampling requirements to be used as a basis for acceptance and rejection of lots, it should prescribe in an operationally definite manner:

1. What is to be considered as a lot
2. The number of units or specimens in the sample
3. The method of selecting the sample from the lot
4. The method of testing a unit or specimen, and of obtaining an "observed value" for the characteristic
5. The calculated function of the several observed values, to be used in determining the conformity of a lot (such as the average, the standard deviation, the number of non-conforming units, etc.)
6. The limits within which the function, referred to in 5, should lie.

The number of units in the sample and the limits to be met by the sample results are particularly susceptible to statistical treatment, since they regulate the chances or risk of accepting unsatisfactory material or of rejecting satisfactory material.

The specification for the die-cast alloy referred to above calls for a sample of five test specimens and requires among other things that the average tensile strength of the five specimens shall be not less than 44,000 lb. per sq. in. What factors enter into the establishment of such a limit, and what must a producer do to assure himself of few failures to meet it?

The statistical approach is concerned with the nature of

[4] For methods of constructing such charts see W. A. Shewhart, "Economic Control of Quality of Manufactured Product," D. Van Nostrand Co., Inc., New York City (1931), or A.S.T.M. Manual on Presentation of Data, Supplement B, *Proceedings* Am. Soc. Testing Mats., Vol. 35, Part 1 (1935).

Figure 1

TENSILE STRENGTH TEST RESULTS
ZINC BASE ALLOY SPECIMENS

EACH DOT REPRESENTS ONE TEST SPECIMEN

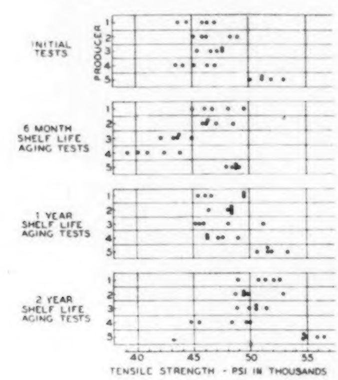


Figure 2

A TYPICAL FREQUENCY DISTRIBUTION

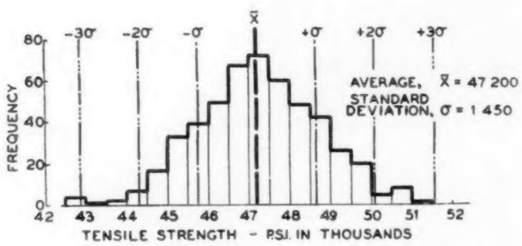


Figure 3

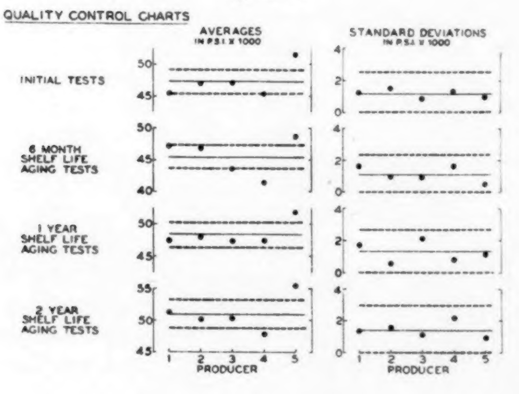


Figure 4

CONTROL CHART SHOWING RELATIVE AVERAGES OF PRODUCERS

ALL TESTS COMBINED

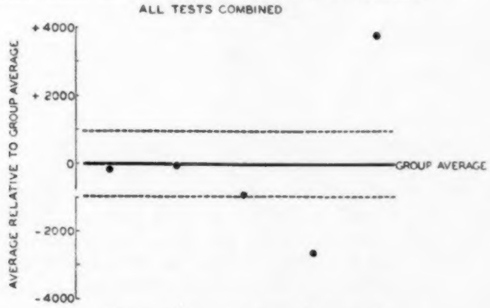


Figure 5

SHOWING DISTRIBUTION OF AVERAGES -
SAMPLES OF 5 SPECIMENS
(σ = 1500 P.S.I. FOR INDIVIDUAL SPECIMENS)

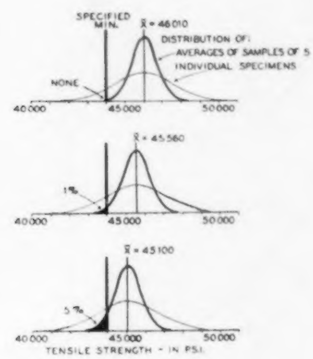


Figure 6

ILLUSTRATING CONTROL OF QUALITY (HYPOTHETICAL)

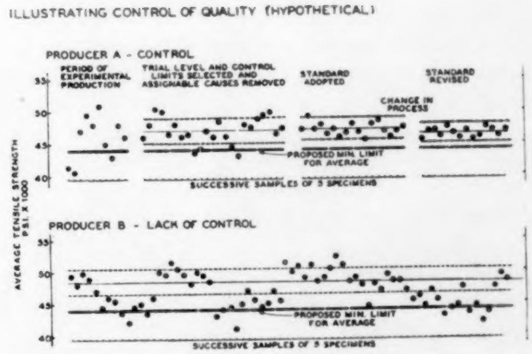
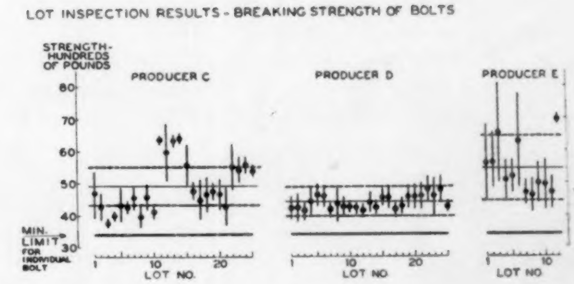


Figure 7

LOT INSPECTION RESULTS - BREAKING STRENGTH OF BOLTS



variation in quality, and here in particular with the question of how widely averages of samples of five will fluctuate. Sampling theory tells us that for a homogeneous product, the range of variation in averages is inversely proportional to the square root of the number of units in the sample. For example, averages of samples of four will vary one-half and averages of samples of 16 only one-fourth as widely as do the values for individual specimens. If a producer had a controlled process which resulted in a distribution of individual specimens with a standard deviation of 1500 lb. per sq. in., then his averages of samples of five would be distributed somewhat as shown in Fig. 5. So long as his process average were controlled at 46,010 lb. per sq. in. or higher, he could expect practically none of his sample averages to fall below 44,000 lb., whereas for levels of 45,560 and 45,080 lb. per sq. in. he could expect 1 per cent and 5 per cent of his averages respectively to fail to meet the critical limit.

But these results are contingent on the assumption that quality is controlled, that the producer has been successful in maintaining consistently the same average and the same standard deviation for his process. How can such a goal be attained and what happens if it is not? To answer these questions brings us back to a consideration of the use of the quality control chart in the plant of the producer.

PRODUCER CONTROL OF QUALITY

Take a hypothetical case of two producers, one who has successfully applied the control chart technique in his plant for security quality control, and one who has not. Experience indicates that in many classes of production problems, upwards of 90 per cent of the causes of lack of control from day to day, from place to place or from one operating group to another, affect averages rather than standard deviations. The following illustrations will accordingly make use of the control chart for averages.

Portions of the first producer's continuing records of lot by lot or day by day results might appear somewhat as shown by the upper diagram of Fig. 6. Following a preliminary period of trial production under experimental conditions, he sets a tentative level for his average and draws in his control limits. He then uses these limits as a basis for action. Each time one or more averages falls outside these limits, he takes this as an indication of a findable cause, investigates, eliminates it if possible, and takes precautionary steps to prevent its recurrence. At first, the more important causes of variation are eliminated by modification in process or human controls. Subsequently the less influential ones are brought to light. In the course of repeated application of this procedure, he may identify some causes whose removal may not be economically feasible—these he leaves alone, but makes due allowance for them. Ultimately, he arrives at a point where all, or practically all, of his averages stay within limits and he has set for himself a standard which he continues to maintain. This standard includes limits, well within the specification limits, that are subject to such changes as the producer may find advantageous from time to time.

The second producer's results, on which are superimposed control chart lines, reflect the presence of uncontrolled influences. While the chart may exaggerate, it indicates a general type of uncertainty, and fails to provide a basis for predicting what may be expected in the future.

RELATION OF CONTROL TO ACCEPTANCE LIMITS SPECIFIED FOR SAMPLES

To what extent does quality control influence the setting of acceptance limits specified for samples?

The first producer, referred to in Fig. 6, when armed with information shown on the chart would have well-founded assurance that a proposed limit for the average, such as 44,000 lb. per sq. in. minimum for samples of five, could easily be met in his plant. He would be able further to estimate pretty closely just how any proposed limit would affect him. The second producer, on the other hand, with his less-well-controlled process, needs for his own protection a rather liberal limit. Even with his higher average value of tensile strength, his chances of running afoul of the specification and incurring the expense of rejections might be considerable.

Knowing that lack of control disclosed by these methods reflects the presence of findable causes, a producer or a committee can make specification decisions with greater confidence if the character and source of such causes of variation are known.

If, then, the acceptance limit for a sample is to be set within a committee in the light of the experience of several producers, it is likely that lack of control will be the strongest influence brought to bear on setting the limit low for producer production. This is also true with respect to the setting of minimum and maximum limits for an individual specimen.

RELATION OF CONTROL TO ECONOMY AND ASSURANCE

In an attempt to summarize what statistical methods can contribute to the solution of quality problems in industry, two words come to mind—economy and assurance. The control chart method is one that has been designed especially to serve these ends by its application to continuing records obtained under mass-production conditions.

The data shown in Fig. 7 may help to illustrate some interesting points. Here are summarized the breaking-strength results obtained for lots of a certain type of $\frac{3}{8}$-in. bolt, submitted by three producers operating under the same specification. Each spot represents the average strength for the individual bolts in a sample and each vertical line, covering a band $\overline{X} \pm \sigma$, indicates the relative spread of strength values for individual bolts. It appears that the average breaking-strength for Producer D is under control, while for Producers C and E it is not. These results bear out certain general comments that can be made with respect to the advantages of securing control.

1. With control, the variation between individual units will be minimized. For Producer D, not only is the total range of variation for all lots smaller, but the variability of bolts within a lot, as indicated by the average length of the vertical lines, is smaller than for Producers C and E.

2. With control, the average can, if desired, be held much closer to the limit. Producer D's average is considerably lower than the averages for C and E. For many characteristics, this may be economically advantageous to the producer.

3. With control, the producer has more latitude in adjusting his target or standard level for any characteristic to the best interests of the resulting product. Often two or more characteristics are interdependent. In this case, too high a tensile strength would be associated with excessive brittleness.

4. With control, the quantity of routine tests by the producer can be reduced. If the production conditions for a current lot

are essentially the same as during the immediately preceding period of control, all that is needed is a sufficient quantity of data to verify the continuance of control. A relatively small sample is usually sufficient for this purpose. Periodic rather than lot by lot inspection may even be found adequate for such verification. Without control, each lot must stand on its own feet, and the sample from it should be large enough to provide adequate assurance that it conforms to specification.

5. With control, consumer acceptance of lots could be based on a declaration of values together with producer's evidence of control, rather than on the results of lot sampling by the consumer. As a matter of fact, maximum economy and assurance can be had only in this way when tests are destructive or costly. Sample testing of lots consigned to a consumer is, at best, often unsatisfactory. The selection of representative samples may be difficult if not impracticable. The number of tests required to give adequate assurance that the lot conforms to a prescribed standard may be extremely large. An extended record similar to that for Producer D in Fig. 7 gives higher assurance to a consumer that the breaking-strength quality of the current product is satisfactory, than can the isolated results obtained from a small sample.[5]

6. With control, the consumer has assurance of a more uniform and dependable product. Uniformities of the past provide the basis for predicting the future. Uniformity of the kind shown by Producer D provides supporting evidence for the prediction that the service performance of successive shipments of product will be closely the same.

[5] For discussion of this point, see H. F. Dodge, "Acceptance-Rejection Requirements in Specifications," *Proceedings* Am. Soc. Testing Mats., Vol. 34, Part II, 1934, and E. S. Pearson, "Application of Statistical Methods to Industrial Standardization and Quality Control," British Standards Institution, 1936.

Citation for Membership Work

During 1936 the membership of the Society increased in a gratifying way, and it is distinctly encouraging to note that a large number of new members have been received during the first three months of the current year. The latest list of new members appears on page 32.

While the particular advantage or asset of membership which influenced a new member to join may not be directly traceable—it may be the desire to work with a new committee, or a need for regular receipt of the publications, or realization of the inherent value of the work and a desire to support it—the direct medium which resulted in a new acquisition was very probably the interest and action of a member.

The Executive Committee is very appreciative of the efforts of the large number of members who have helped in various ways in obtaining new members. Because of the outstanding interest of certain men in membership work, the Executive Committee wishes to make special mention of them. During 1936 the names of members in the following list have appeared on three or more new members' application blanks:

H. J. Ball	J. O. Leech
T. A. Fitch	M. Rea Paul
Dean Harvey	C. H. Scholer
Carl E. Heussner	H. P. Trevithick
G. E. Hopkins	E. W. Upham
H. L. Kennedy	W. H. Whitcomb
E. F. Kenney	Henry Wysor

There are a number of other active members who have done yeomen service, not only in actually obtaining a new member, but in follow-up work.

Every member who helps in this essential work is rendering distinct service to his Society.

International Congress for Testing Materials

There was announced in a previous Bulletin a list of some twenty-two papers to be presented by American authors at the International Congress in London, April 19-24, sponsored by the International Association for Testing Materials. Arrangements for the Congress are in the charge of a British Committee consisting of a number of leading British engineers and scientists. Many of the British scientific and technical institutions are assisting with the Congress.

The total number of papers to be presented is in excess of 200, and the list of provisional papers is a most interesting one. The papers are divided into four groups: Metals, Inorganic Materials, Organic Materials and Subjects of General Importance. In the first-named group, there are numerous papers on behavior of metals as dependent on temperature, progress in metallography, light metals and their alloys and wear and machinability. The sections under inorganic materials involve concrete and reinforced concrete, erosion and corrosion of natural and artificial stone, and ceramic materials.

Subjects to be covered by a number of papers in each division under the general heading of organic materials comprise textiles, wood cellulose, timber preservation, aging of organic materials, colors and varnishes, while subjects of general importance to be covered include relation between the results of laboratory tests and behavior in use and service, the bearing of recent advances in physics and chemistry on the knowledge of materials and the properties of materials for the thermal and acoustic insulation of buildings.

The papers are being developed by authorities in some twenty different countries and they will be published in a Congress Book which will also include a report of discussions. Subscriptions for advance papers and Congress Book, to April 15, are 21 shillings, and after that date, 31 shillings.

A number of authors from the United States are planning to attend the Congress including the following:

L. E. Barringer, General Electric Co.
W. E. Emley, National Bureau of Standards.
C. E. MacQuigg, Union Carbon and Carbide Research Labs.
J. W. McBurney, National Bureau of Standards.
A. Nadai, Westinghouse Electric and Manufacturing Co.
H. D. W. Smith, A. M. Tenney Associates.

In addition, Messrs. L. J. Markwardt, Forest Products Laboratory, and R. L. Templin, Aluminum Company of America, have advised that they will attend.

Messrs. W. E. Emley and R. L. Templin will act as official representatives of A.S.T.M. at the Congress.

Society Cable Address

It will be noted from the heading on page 1 of the Bulletin that a registered cable address is given. Because it is necessary at times for members of the Society and other individuals and organizations in distant countries to obtain information or publications promptly, it was deemed advisable to have a cable address registered. The code word assigned is "Testing," Philadelphia. Announcement of this address will be of particular interest to our far-distant members.

A. S. T. M. BULLETIN

Published Bi-Monthly by

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Number 85 — March 27, 1937

Producer and Consumer Research

FORTUNATE is a standing committee which deals with materials that are produced by strong industrial groups that have laboratories and technical staffs to conduct the research necessary for the formulation of adequate standards. The regional meeting symposia held at Chicago were excellent examples of the new knowledge on properties of materials and on methods of testing that is obtained by well-balanced, strongly supported committees.

The Symposium on Corrosion Testing held a large audience from eight o'clock to nearly midnight; producers of ferrous and non-ferrous metals, consumers and general interests contributed papers and discussions on this important subject. The Symposium on Lubricants on the following day included results of tests and research from representatives of oil companies, automobile manufacturers, and truck operators. After hearing these discussions one could not leave the meeting without feeling that any methods of test or specifications developed by either the corrosion or lubricants committees would have a sound foundation of critical investigation both from the angle of the producer and that of the consumer.

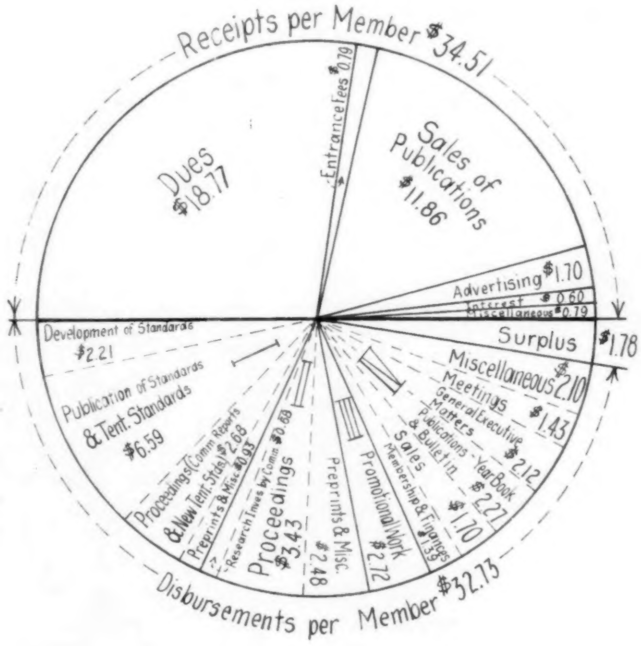
Some of our standing committees do not have the advantage of equally competent technical representations from the various interests concerned. The consumers of certain non-metallic materials, particularly in the building industries, do not have research laboratories or materials technologists in their organizations. In such cases the committee must rely largely on government, municipal, and technical school laboratories for research from the consumer point of view. It is hoped that such committees will avail themselves of this disinterested assistance so far as possible to maintain the proper judicial balance that is the prime purpose of the A.S.T.M.

A. C. Fieldner

President.

Notes on Society Finances

THE following figures taken from the Secretary-Treasurer's report to the Executive Committee in January tell an interesting story of the finances of the Society for 1936. Total receipts for that year were $131,805, comprising $74,711 from dues and entrance fees, $45,290 from sales of publications, and $11,804 from advertising, interest and miscellaneous sources. Dues and entrance fees were up about $5,000 over the preceding year; sales of publications, the largest in the Society's history. Receipts from this source have grown greatly in the last three years, indicating a strong industrial demand for both the regular and special publications of the Society. Advertising in the BULLETIN and in the Index to Standards and Tentative Standards increased about one-third over the preceding year; the BULLETIN, even



with the considerable increase in its size, is on a self-sustaining basis, considering the cost of printing and distribution, and the Index is nearly so.

Total disbursements for the year were $125,012, leaving a balance transferred to surplus of $6,793. Of this amount $2,500 was transferred to the principal of the A.S.T.M. Research Fund.

The accompanying chart shows receipts and disbursements on the per member basis, the disbursements classified in the following four divisions:

I. Standardization, Development and Promulgation	$12.41
II. Advancement of Knowledge of Materials	6.59
III. Promotional Work	2.72
IV. Administrative Work	11.01
	$32.73

The budget for 1937 has been based upon an estimated total income of $142,250, which anticipates further membership growth, continuing demand for the Society's publications, especially the newly published Book of A.S.T.M. Standards, and income from advertising, registration fees, the Fourth A.S.T.M. Exhibit and miscellaneous sources.

Subcommittee on Paper Shipping Containers

At a well-attended meeting held in Chicago during Committee Week, there was organized Subcommittee IV on Paper Shipping Containers of A.S.T.M. Committee D-6 on Paper and Paper Products. The function of this subcommittee is the development of standard methods of testing and of specifications for paper shipping containers and of the paper and paper board from which they are constructed. The meeting was held under the chairmanship of Don L. Quinn of Chicago who has been designated as chairman of the subcommittee by Roger C. Griffin, Director of Tests, Arthur D. Little, Inc., who is chairman of the general Committee D-6. The provisional personnel of the subcommittee is as follows:

Bird and Son, Inc., East Walpole, Mass.
Container Corporation of America, J. J. Brossard and C. P. Barker, Chicago, Ill.
Crown-Zellerbach Corporation, San Francisco, Calif.
Dahill, Edward, Chief Engineer, Freight Container Bureau, Association of American Railroads, New York City.
Gaylord, Inc., Robert, H. L. Bode, In Charge of Laboratory, St. Louis, Mo.
General Electric Co., R. L. Beach, Schenectady, N. Y.
Greenly, A. H., Chairman, Official Classification Committee, New York City.
Luhrs, A. W., President, Container Testing Laboratories, Inc., New York City.
Malcolmson, J. D., Director of Research, Robert Gair Co., Inc., New York City.
The Mengel Co., Louisville, Ky.
Montgomery Ward Co., Chicago, Ill.
National Association of Purchasing Agents, J. M. Berry, The Drackett Co., Cincinnati, Ohio.
Quinn, Don L., The Don L. Quinn Co., Chicago, Ill.
Southern Kraft Corporation, New York City.
U. S. Forest Products Laboratory, C. E. Curran, Madison, Wis.
Van Zile, B. S., Chemist, Colgate-Palmolive-Peet Co., Jersey City, N. J.
Western Electric Co., G. J. Behnke, Chicago, Ill.

C. P. Barker, Container Corporation of America, was elected secretary of the subcommittee.

The meeting was devoted to a thorough discussion of the testing problems before the committee with particular reference to tests of paper and paper board of particular significance in the construction of containers. Questions of humidity and temperature control during testing and the significance of moisture content and its relation to strength properties of these products received special attention and the committee's first work will be in this direction.

Distribution of Standards Index Completed

The members of the Society will no doubt be interested in the change that has been effected in the typography of the Index to A.S.T.M. Standards and Tentative Standards, distribution of which has recently been completed. It is felt that this change will make the Index more useful in that employing the double column form brings more items on a page, thus cutting down in the amount of leafing over that is required in order to locate the item desired. This has been done with no loss in legibility since a very readable type has been employed in the new format. With it all an economy has been effected due to the fewer number of pages that are required and, with an edition of 12,000 and more copies, which is our usual printing, this is no small consideration.

Attention is again called to the fact that additional copies may be obtained upon request.

Schedule of A.S.T.M. Meetings

Date	Committee	Place
April 6	Committee B-2 on Non-Ferrous Metals and Alloys	New York City
	Committee B-5 on Copper and Copper Alloys, Cast and Wrought	New York City
April 12	Committee E-9 on Research	Philadelphia
April 12, 13, 15	Committee D-1 on Paint, Varnish, Lacquer, and Related Products	Durham, N. C.
April 20	Executive Committee	Philadelphia
April 5	Philadelphia District Meeting	Philadelphia
April 7	Detroit District Meeting	Detroit
June 28-July 2	Annual Meeting	New York City

Contributions to Wire Corrosion Program

It is with pleasure and appreciation of their interest in the research work of the Society that we acknowledge in these columns the receipt of two substantial financial contributions to the Research Fund of Committee A-5 on Corrosion of Iron and Steel in support of the atmospheric corrosion tests on wire, strand and fencing, described in the December, 1936, Bulletin. First is a contribution of $2,000 from the American Zinc Institute, made last year, which was applied toward the costs of assembling and fabricating the wire and fence samples and erecting them at the eleven test sites. The second is a grant of $6,000 recently received from the Utilities Coordinated Research, Inc., of which Dr. C. F. Hirshfeld, Chief of Research Department, Detroit Edison Co., is president. The U.C.R. represents the research interests of many of the largest power and light utilities in the country and the data on corrosion resistance that will develop from this project will be of much value to the power and light industry. Arrangements have been made for the U.C.R. to be represented on Committee A-5 and the Wire Corrosion Inspection Committee, where their cooperation in inspection, interpretation and reporting of data will be most helpful. The American Zinc Institute has been a member of Committee A-5 for some years.

WIRE SAMPLES TESTED AT THE BUREAU OF STANDARDS

The next stage in this project is the important one of determining the chemical composition, physical properties and metallographic characteristics of samples of all wire, strand and fence, thus establishing for reference purposes the "initial" properties of the material being tested. This work will be done at the National Bureau of Standards through the establishment of two research associateships at the Bureau, made possible by the U.C.R. grant mentioned above.

The test samples, identified completely in relation to the material in the field but without identity of the manufacturer, have been shipped to the Bureau. This work will involve many hundreds of chemical determinations, weight of coating determinations, physical and metallographic tests, and is expected to require about a year. Periodic reports will be made to Committee A-5 and the complete data will be published in one of the committee's reports.

Committee on Cement Meets

At the meeting of Committee C-1 on Cement in New York City on February 23, reports were submitted by various subcommittees, outlining the work in progress and new work just being undertaken. There were also brief discussions of some of the recent developments in test methods and specification requirements.

Certain actions at the meeting were of particular interest and guided by recent work of the subcommittees, it was voted, subject to letter ballot by Committee C-1, that the following recommendations should be presented to the Society:

1. Approval for publication as tentative of the recently proposed specifications for blended cements.
2. Delete the No. 200 sieve fineness requirement from the present Specifications for Portland Cement (C 9 - 30).
3. Make certain revisions in details of the Tentative Method of Test for Compressive Strength of Portland Cement Mortars (C 109 - 34 T) and retain the method as revised as tentative for another year.
4. Adopt as standard, with certain minor changes, Sections 1 to 10 of the present Tentative Methods of Chemical Analysis of Portland Cements (C 114 - 35 T), thus superseding Sections 8 to 11 of C 77 - 32, Methods of Sampling and Testing Portland Cement; retain as tentative Sections 11 to 14 of C 114 - 35 T; approve as tentative the improved methods, recently presented to Committee C-1, for determining manganese and phosphorus in portland cement.
5. Adopt as standard the recently proposed new Specifications for Natural Cement, thus replacing the present standard C 10 - 09.

In a cooperative series of tests 8 or 10 laboratories are about to start work on autoclave tests of some 30 cements. The work will include the study of a number of the variables involved in the test methods.

Special Summer School on Strength of Materials at M. I. T.

A special summer program and conference on strength of materials have been arranged at Massachusetts Institute of Technology for four weeks beginning June 21. The program is offered by the Department of Mechanical Engineering and Prof. J. M. Lessells is in charge. The program is divided into a series of lectures on creep, fatigue of metals, strength of materials and includes laboratory exercises on strength of materials with certain seminars and conferences.

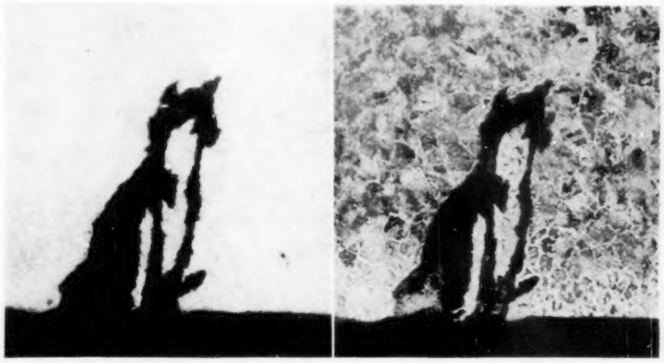
The subject of creep will be presented by Dr. A. Nadai, Consulting Engineer, Westinghouse Electric and Manufacturing Co., while the lectures on fatigue of metals are to be given by Dr. H. J. Gough, Superintendent, Engineering Dept., National Physical Laboratory, England. Both Doctors Nadai and Gough delivered A.S.T.M. Marburg Lectures, Doctor Nadai in 1931 and Doctor Gough in 1933.

The lectures on strength of materials will be given by members of the Institute's staff including Professors Lessells, Cowdrey, Vose and MacGregor.

For the complete program the tuition fee is to be $80. Further particulars may be had by contacting Professor Lessells, Department of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

UNIQUE INTEREST COLUMN

Editor's Note.—From time to time, our attention has been directed to unusual and very interesting items, special photographs, unique stories, old-time specifications, etc., and at the suggestion of certain members it has been decided to institute a "unique interest column" in the Bulletin, beginning with this issue. Because of the unusualness of the items, it is believed they will be of wide general interest, even though they may refer to a specific field. Material for this column will be welcome from any of the members and those who may have information in their files or know of sources where appropriate items can be obtained are urged to send them to Society Headquarters. It is planned that the items used will relate to the materials field, but they may not necessarily refer specifically to standardization or testing. The column will be essentially a members' column and the names of members submitting items will of course be given.



Unetched   Etched

Photomicrographs, at one-hundred diameters, occasionally reveal unusual inclusions. Observe the cat on the back fence found at one-hundred diameters in steel. (Submitted by H. H. Morgan.)

Awards for Scientific Papers on Arc Welding

To encourage scientific interest in arc welding, the James F. Lincoln Arc Welding Foundation is offering awards of $200,000 to authors of satisfactory papers on this subject. Competition is divided into such major divisions as automotive, aircraft, railroad, structural, functional machinery, etc., and each major division is subclassified so that for each subdivision there will be five prize awards. For each major division four papers will be selected to receive additional awards and from the eleven winning papers will be chosen four to receive the main prizes. The winner of the grand prize will receive not less than $13,700 for his paper.

Anyone interested in entering the competition should communicate with the Secretary, The James F. Lincoln Arc Welding Foundation, P. O. Box 5728, Cleveland, Ohio.

Discussion of Corrosion and Lubricants Symposiums

Members of the Society and others who wish to submit written discussion of the six papers comprising the Symposium on Corrosion Testing Procedure or the four papers in the Symposium on Lubricants, both held as technical features of the Chicago Regional Meeting of the Society, are requested to submit copies of their discussion in duplicate as soon as possible. The Committee on Papers and Publications has set April 20 as the closing date.

Important Actions During Committee Week

(Continued from page 6)

and the original history and fabrication procedure of the alloys under its jurisdiction. A small committee was appointed to study the possibilities of such a program for presentation to the main committee at its next meeting.

Committee on Wrought Copper and Copper Alloys

The Subcommittee on Wrought Metals and Alloys of A.S.T.M. Committee B-5 on Copper and Copper Alloys, Cast and Wrought, considered in detail two proposed tentative specifications, one for rolled non-ferrous bearing plates for bridge and other structural uses, the second covering seamless condenser tubes and ferrule stock. It is planned to submit these specifications to Committee B-5 shortly for approval.

The first-named specifications cover rolled non-ferrous plates used in bridges and other structures for fixed or expansion bearings where motion is slow and intermittent and pressure does not exceed 3000 lb. per sq. in. Two types of composition are provided, one with a minimum tin of 3.8 per cent, maximum phosphorus 0.5 per cent and the sum of these elements, plus copper, minimum 99.5 per cent. The other type provides for a minimum copper content of 94.8 per cent, with silicon in the range 2.70 to 3.75. Certain other elements may be present within specified limits. These specifications represent an extensive revision of the existing Tentative Specifications for Wrought Phosphor-Bronze Bearings and Expansion Plates for Bridges and Structures (B 100 - 35 T), and are intended to replace these specifications when issued.

The specifications for condenser tubes and ferrule stock cover seamless tubes and ferrule stock of various alloys for use in surface condensers, evaporators and heat exchangers. The chemical composition requirements provide for various types of alloys including Muntz metal, admiralty, red brass, aluminum brass and aluminum bronze, 70 - 30 and 80 - 20 copper nickel, copper, and arsenical copper. When approved as tentative it is anticipated that this new specification will be a consolidation and replace other existing standards covering specific materials.

Committee B - 6 on Die-Cast Metals and Alloys

A decision to expand its present extensive corrosion test program to include indoor and outdoor exposure tests on three magnesium-base alloys, was reached at the meeting of Committee B-6. The alloys were selected as representative of best American and European practice. The committee plans to bring in samples of the alloys at the end of five and ten years and the third period will depend on the status of the tests. Specimens representing these three alloys will be exposed at the six outdoor and four indoor locations used in the present tests. Various producers of the alloys will furnish the test specimens and the erection of the test racks and inspection and testing of the samples will be carried out by other members of the committee.

In planning for its 1937 report, the committee intends to include two interesting papers as appendices. One of these on the subject of brass die castings will discuss in detail developments to date in this field. The paper is to be prepared by J. C. Fox, Doehler Die Casting Co.

The second paper will be developed by G. L. Werley of the New Jersey Zinc Co. on the effect of the die design on the properties of zinc-base test specimens. This paper will deal with such subjects as methods of channeling, runners, and it is anticipated that there will be considerable X-ray and mechanical data included.

The subcommittee on tin and lead-base die-casting alloys perfected plans to undertake extensive series of tests on five lead and tin-base die casting alloys which are representative of American practice. The comprehensive test program involves a series of tension tests, and impact and hardness tests are to be included. The committee will also start long-time creep tests.

The committee plans to recommend a revision of the Specifications for Aluminum-Base Alloy Die Castings (B 85 - 33 T). This change will include the insertion of Alloy No. XI and informative data concerning its properties will be included in the table appended to the specifications. This alloy has a nominal composition of 2 per cent copper, 8 per cent silicon, 1.5 to 2.0 per cent iron, 0.05 max. manganese, 0.05 max. magnesium, with aluminum the remainder.

Committee B - 7 on Light Metals and Alloys

The Subcommittee on Aluminum and Aluminum Alloy Ingots completed extensive revisions of the Tentative Specications for Aluminum-Base Sand-Casting Alloys in Ingot Form (B 58 - 33 T). The revised specifications are intended to replace the existing ones and, after approval by letter ballot of Committee B - 7, will be submitted to the Society in June. This subcommittee has prepared specifications for aluminum-base permanent mold casting-alloys which will be in the nature of companion specifications to the Tentative Specifications for Aluminum-Base Alloy Permanent Mold Castings (B 108 - 36 T). The subgroup is also reviewing a tentative draft of specifications for aluminum-base die casting alloys in ingot form. This work is being carried on in cooperation with A.S.T.M. Committee B-6 on Die-Cast Metals and Alloys. The committee will give consideration to bringing the requirements for ingots for die castings in line with the revisions that have been made in the specifications for the finished castings.

The Subcommittee on Testing Light Metals has completed a series of tests to obtain information on the modulus of rupture of aluminum alloys. The data obtained in these studies will be presented in the form of a technical paper to be appended to the 1937 annual report of Committee B-7. The paper will contain data on some seven or eight of the aluminum alloy castings as covered in the A.S.T.M. Tentative Specifications for Aluminum-Base Alloy Sand Castings (B 26 - 36 T). This subcommittee also reported that consideration is being given to obtaining information respecting the relative hardness of the various aluminum-base alloy castings as covered by Specifications B 26, and also of the aluminum-base alloy permanent mold castings as covered in the Tentative Specifications B 108 - 36 T.

Joint Committee on Effect of Temperature on Metals

The Joint Research Committee on Effect of Temperature on the Properties of Metals, jointly sponsored by the

American Society of Mechanical Engineers and A.S.T.M., considered a number of matters in connection with the work of the committee, particularly with respect to a reorganization of the committee's setup. A number of new members are to be added after approval by the sponsor bodies and will be assigned to service on the committee.

At the meeting, N. L. Mochel, Westinghouse Electric and Manufacturing Co., who has served as secretary for a number of years, was elected as vice-chairman; J. W. Bolton, The Lunkenheimer Co., was chosen secretary, and Messrs. F. B. Foley, The Midvale Co., and E. L. Robinson, General Electric Co., were elected to the Executive Committee. These four men, with the chairman, H. J. French, International Nickel Co., will comprise the Executive Committee.

As new projects are undertaken in the future, the Executive Committee or the chairman will appoint a chairman of a special committee to handle the project, and upon completion of a project, the special committee is to be automatically discharged.

Technical projects were agreed upon as follows:

Project No. 10.—Testing of Tubular Members. C. E. MacQuigg, chairman. Work to be carried out at Massachusetts Institute of Technology.

Project No. 11.—Assembly and Interpretation of Available Creep Data. P. E. McKinney, chairman. This work has been under way since last year at the University of Michigan.

Project No. 12.—Continuation of a Long-Time Creep Test on K-20 Carbon Steel, at Battelle Memorial Institute. H. W. Gillett, chairman.

Project No. 13.—Investigation of Properties of Metals at Low Temperatures. H. W. Russell, chairman. This committee is conducting a questionnaire on this matter.

Project No. 14.—Study and Revision of Tentative Method of Test for Long-Time (Creep) High-Temperature Tension Tests of Metallic Materials (E 22 - 35 T). C. L. Clark, chairman.

Project No. 15.—Torsion Creep Tests for Comparison with Tension Creep Tests. A. E. White, chairman. This work is to be done at the University of Michigan.

Project No. 16.—Relaxation Tests. E. L. Robinson, chairman.

Project No. 17.—Study of High Temperature Acceptance Test Methods. A. E. White, chairman.

Project No. 18.—Study of Effect of Manufacturing Variables in Steel Manufacture on the Creep Resistance. H. W. Gillett, chairman.

Project No. 19.—Procurement of Materials for Projects Nos. 10, 15, 16, 17.

Research Committee on Fatigue of Metals

At the meeting of the Research Committee on Fatigue of Metals there was informal discussion of outstanding unsolved research problems in connection with failure of metals when subjected to repeated loading. A number of problems were outlined, including the following:

1. Strength developed in specimens when tested in different ways—direct repeated pull, repeated bending, repeated twisting, differences between results with solid and hollow specimens.
2. The effect of lubricant in changing the strength of parts subjected to repeated pressure over a small area, such as gear teeth, ball bearings, and car wheels.
3. The behavior of different metals when subjected to loads above the smallest value which will cause eventual failure—the length of "life" which can be expected for such loads, and the lowered resistance to subsequent repetition of lower loads.
4. The effect of cold working and heat treatment on the crystalline structure of metals and the resultant effect on resistance to repeated stress and the damage done by occasional overstress.
5. The effect of speed of repetition of load on the resistance to repeated stress.

Joint Committee on Exposure Tests of Plating on Non-Ferrous Metals

About 75 persons attended the conference of the Joint Committee on Exposure Tests of Plating on Non-Ferrous Metals. Dr. William Blum, chairman of the committee, presided. Data giving the results of exposure tests to date were distributed and discussed, and it was agreed that the present system of rating on a numerical scale furnished a good basis for comparison of the coatings.

The effects of cleaning and protecting the plated surfaces with grease or wax were illustrated by actual specimens from the racks in New York. It was decided to expose new specimens of about 30 typical sets to which the cleaning and protective films would be applied at the start and at regular intervals thereafter.

It was also recommended that some new sets with different methods of preparation and thickness of coating be prepared and installed as soon as feasible. Pending the results of these supplementary tests no conclusions from the research are to be published.

Committee C-7 on Lime

Committee C-7 considered detailed specifications for two types of chemical lime used in the paper and pulp industry. The first of these covers lime for causticizing carbonate liquors from the soda pulp process where the lime sludge can be used as a pigment or filler in the paper. The second specification covers quicklime for causticizing leached liquors in the soda pulp process for the manufacture of paper. It is stated in the specifications that in the manufacture of pulp by the soda process the wood is cooked with a caustic soda solution which dissolves the non-celluloses of the wood substance and is obtained as black liquor after washing the pulp. This is evaporated and burned in rotary furnaces or spray-type furnaces, the resultant product being sodium carbonate which is leached from the black ash if the rotary type furnace is used, or as a solution of sodium carbonate from the molten soda ash discharged from the hearth of the spray-type furnace. Lime is used to reconvert the sodium carbonate into caustic soda.

Action was taken to recommend the publication of both of these specifications with the annual report of the committee, as information only, for the purpose of soliciting constructive criticisms and suggestions for improvement.

Committee C-9 on Concrete and Concrete Aggregates

For the past several years, Committee C-9 has been studying requirements for lightweight aggregates. This work has now resulted in the preparation of specifications for lightweight aggregates for concrete which were accepted by the committee at its meeting subject to approval by letter ballot vote for presentation to the Society as a new tentative standard.

The committee has been giving detailed consideration to the various specifications and methods of test under its jurisdiction and revisions which are expected to be submitted to the Society were recommended in the following four specifications and one method of test:

Curing Portland-Cement Concrete Slabs with Calcium Chloride Admixture (C 82 - 34).

Curing Portland-Cement Concrete Slabs by Surface Application of Calcium Chloride (C 83 - 36).

Ready Mixed Concrete (C 94 - 35).
Concrete Aggregates (C 33 - 36 T).
Method of Making and Storing Compression Test Specimens of Concrete in the Field (C 31 - 33).

The withdrawal of the Test for Absorption by Aggregates for Concrete (Laboratory Determinations) (C 95 - 36) and the Field Test for Absorption of Mixing Water by Aggregates for Concrete (C 96 - 36) will be proposed, inasmuch as these methods have been superseded by the Tentative Method of Test for Specific Gravity and Absorption of Coarse Aggregate (C 127 - 36 T) and Fine Aggregate (C 128 - 36 T), which latter methods were issued in 1936 as tentative.

Action was also taken to recommend the adoption as standard of the Tentative Method of Test for Determination of Amount of Material Finer than No. 200 Sieve in Aggregates (C 117 - 35 T). This method was prepared by Committee C-9 in cooperation with Committee D-4 on Road and Paving Materials as a revision of the decantation test procedures described in the existing Standard Method of Test for Quantity of Clay and Silt in Gravel for Highway Construction (D 72 - 21) and Standard Method of Decantation Test for Sand and Other Fine Aggregates (D 136 - 28). With the adoption as standard of Tentative Method C 117 these two latter methods will be withdrawn. Committee C-9 will also propose the adoption as standard of the Tentative Method of Test for Determination of Voids in Coarse Aggregate for Concrete (Dry Rodded) (C 30 - 35 T). This test procedure will supplement the Standard Method of Test for Determination of Voids in Fine Aggregate for Concrete (C 30 - 22).

A.S.T.M. Committee D-2 on Petroleum Products and Lubricants

At the meeting of Committee D-2, the Subcommittee on Corrosion Test for Lubricating Oils presented preliminary data on independent work conducted in fourteen laboratories. The results justified the collection and presentation of the material for general information.

The Subcommittee on Grease has prepared and offered for publication a method for the determination of dropping point. Progress was also reported on the determination of the consistency of soft greases and the development of a penetration method which can be applied to minute samples.

There was spirited discussion on a number of points at the meeting of the Subcommittee on Viscosity. This group recommended that a revision of the kinematic-Saybolt viscosity conversion table, published in 1936, be approved as a standard method. In its 1936 report, the committee included, as information, proposed methods of test for kinematic viscosity by means of the suspended level and modified Ostwald viscosimeters. By action of Committee D-2, these proposed methods are to be consolidated into a single document and it is planned to submit this to the Society for approval as a new tentative test method.

Based on a study of more accurate data which has become available, minor revisions in the present viscosity-temperature chart (D 341 - 32 T) are in prospect.

The recently created Subcommittee on Plant Spray Oil has developed distillation and unsulfonated residue methods, which were recommended for submission as tentative standard methods.

The Subcommittee on Natural Gasoline has effected a reconciliation of the two current vapor pressure (Reid) methods (D 323 - 32 T and D 417 - 35 T) and presented a consolidated method, which will be submitted to the Society as a proposed new tentative standard.

The committee has approved proposed tentative specifications for gasoline and these are now being considered by the A.S.T.M. Committee E-10 on Standards. If approved by the Standards Committee they will be published as tentative. The specifications are suggested to aid purchasing agencies in formulating specifications; they are not intended to define gasoline nor do they include all grades satisfactory for motor vehicles. They do state the required properties of gasoline at the time and place of delivery in bulk.

Committee D-3 on Gaseous Fuels

One of the first essentials in formulating standards for testing gaseous fuels, now being undertaken by Committee D-3, is the problem of specifying ways and means for obtaining accurate samples of gases. Such items as containers for samples, types of sampling tubes to be employed, size of samples, as well as proper methods of procuring, transporting and storing samples are all being studied by the Subcommittee on Collection of Gaseous Samples.

A second subcommittee is engaged in preparation of methods for the volumetric measurement of gases. This committee's work has progressed to the point where it has initiated several preliminary research projects at the National Bureau of Standards and the American Gas Association's Testing Laboratories.

A third group is engaged in the preparation of standard methods for a determination of heating value of gases and definitions to be employed therewith. A thorough study of existing methods for such determination is being carefully made by this group, and some investigational work on such subjects may also be undertaken.

A fourth subcommittee is giving full consideration to existing methods and apparatus now employed for the determination of specific gravity and density of gaseous fuels. The objective of this group is to select some existing and entirely satisfactory procedures for determining such information. It is entirely probable that this committee may find it necessary to develop new methods, or what is more probable, modify existing ones.

Certain constituents are found in most commercial gases which may be regarded as undesirable when viewed from the standpoint of the use to which such gases are to be put. Such components are commonly referred to as impurities. Accordingly a subcommittee has been formed and is at present engaged in the preparation of a standard procedure for determining existing quantities of such undesirable constituents.

A sixth group has already made a very extensive study of methods now employed for determining small quantities of water vapor in fuel gases. Research on this subject is now under way at Pennsylvania State College. Most promising among the methods studied to date appear to be the thermal-conductivity and electrical dew point methods.

The seventh subcommittee is confining its activity at the present time to a broad study of the subject of chemical analysis. Tentative tolerances have already been accepted and a study of the different methods and apparatus employed for such work is well under way.

Committee D-4 on Road and Paving Materials

Through its Subcommittee on Size of Aggregates, Committee D-4 on Road and Paving Materials has made a comprehensive study of the various specifications and methods of test for aggregates under its jurisdiction. The committee had previously prepared a tentative method of test (C 117) for determination of amount of material finer than No. 200 sieve in aggregates. The committee decided to recommend to the Society the adoption of this method as standard. This test will replace the existing Test for Quantity of Clay and Silt in Gravel for Highway Construction (D 72 - 21) and Method of Decantation Test for Sand and Other Fine Aggregates (D 136 - 28).

The committee has prepared new specifications for standard sizes of coarse aggregates for highway construction which represent a consolidation and revision of the existing Tentative Specifications for Commercial Sizes of Broken Stone and Broken Slag for Highway Construction (D 63 - 23 T) and for Commercial Sizes of Sand and Gravel for Highway Construction (D 64 - 20 T). The revised specification will cover standard size designations and maximum permissible ranges in mechanical analyses in standard sizes of coarse aggregates and screenings for use in the construction and maintenance of various types of highways and highway structures. The Standard Form of Specifications for Certain Commercial Grades of Broken Stone (D 35 - 18), which was adopted in 1918, is now considered unnecessary and will be withdrawn.

As a result of a study of the four existing standard methods of mechanical analysis of aggregates (D 7, D 18, D 19 and C 41), the committee has decided to undertake the preparation of a single method of test. This work will be carried on in cooperation with Committee C-9 on Concrete and Concrete Aggregates, which committee is also interested in the tests of this nature.

The Subcommittee on Abrasion of Aggregates has been studying for the past two years a new abrasion test for aggregates using the Los Angeles apparatus. A proposed method of test was published as information only in 1935. The subcommittee has now completed certain improvements in the test method as originally published and Committee D-4 plans to submit it for publication as an A.S.T.M. tentative method under the title of "Tenative Method of Test for Abrasion of Coarse Aggregate by the Use of the Los Angeles Test Machine." The method covers the abrasive resistance of crushed rock, crushed slag, uncrushed gravel and crushed gravel. The committee also completed the preparation of certain desirable revisions in the existing Tentative Method of Test for Abrasion of Gravel (D 289 - 28 T) which will be submitted for approval.

Committee D-5 on Coal and Coke

Committee D-5 plans to recommend extensive revisions of the Method of Test for Grindability of Coal by the Hardgrove-Machine Method (D 409 - 35 T). These revisions will considerably shorten the test procedure by eliminating the large number of sieves now required for size testing the ground coal. In the revised procedure only one sieve, the No. 200 sieve, is used in size testing the coal at the completion of the test. Revisions are also to be made in the Test for Grindability of Coal by the Ball-Mill Method (D 408 - 35 T). These revisions include a rapid control method suitable for use on coals, the general grindability characteristics of which are known. This rapid control method requires only about one-half the time of the standard procedure which is recommended for testing coals of unknown grindability characteristics.

A revision will be submitted in the standard method of sampling to provide a scheme of crushing and reducing gross samples of coal by mechanical crushers and riffler samples. Such mechanical methods are now in general use where much coal sampling is done. It is believed that a standard method of mechanical reduction will be welcomed by coal producers and consumers because of the great saving over hand methods. Also, a well-standardized mechanical method should be more accurate because of the elimination of personal errors inherent in hand methods of preparing coal samples for shipment to the laboratory.

Two methods for testing coal friability or the resistance of coal to breakage on handling were approved for presentation to the Society as tentative standards. One of these methods is a tumbler test and the other a drop shatter test. These have been published for information in the book on "A.S.T.M. Standards for Coal and Coke."

Organization was completed of a new subcommittee on plasticity and swelling of coal. This subcommittee will investigate methods for determination of plastic properties of coals and their swelling or expansion when heated or burned. The methods will concern the evaluation of coals for coke making and as affecting their burning characteristics in the fuel bed.

Committee D-8 on Bituminous Waterproofing and Roofing Materials

The Subcommittee on Specifications for Membrane Materials, of Committee D-8, has made a comprehensive survey of the various specifications for membrane waterproofing and roofing materials and has completed a revision of the existing Tentative Specifications for Asphalt Cap Sheet Surfaced with Mineral Granules (D 371 - 33 T) so as to cover both 44-lb. and 55-lb. weights of cap sheet made on No. 33 and No. 50 felts, respectively. The revised specifications are expected to be presented as a revision of and to replace Specifications D 371. Following a study of the existing specifications covering asphalt for damp-proofing and waterproofing below ground level (D 40 - 36 T) and above ground level (D 144 - 36 T), the subcommittee has combined and revised these specifications so as to bring them into accord with present practice in the industry.

After a careful study of the five existing specifications for coal-tar pitch for roofing, damp-proofing and waterproofing, the committee has decided to cover these materials in a single specification which will provide for two types—Type A for roofing and waterproofing above ground level and Type B for waterproofing below ground level. The new specifications represent a revision and consolidation of the existing standards.

The subcommittee has reviewed four of its existing tentative specifications for asphalt roofing and asphalt shingles surfaced with mineral granules, or with powdered talc or mica. In each of the specifications, methods for more adequately specifying the quantity and type of mineral filler in the coating are being considered. The present recommendations are based upon the results reported by Dr. O. G. Strieter in his paper "The Effect of Mineral Fillers on the

Serviceability of Coating Asphalts" presented at the 1936 Annual Meeting of the Society. The subcommittee would welcome any data or recommendations on this point which can be furnished by those interested in the subject. The whole subject of prepared roofing and shingle specifications is being studied with the idea of developing specifications based entirely on physical and performance tests rather than upon composition requirements.

A revision of the Specifications for Asphalt for Use in Constructing Built-Up Roof Coverings (D 312 - 35 T) has been completed and studies of the Test for Coarse Particles in Mixtures of Asphalt and Mineral Matter (D 313 - 35 T) have been made to determine whether check results could be obtained by different operators. A series of cooperative comparative tests were made in the laboratories of six members of the subcommittee on samples of fluxed native asphalt and mineral filled asphalt conforming to Specifications D 312 and to the Federal Specifications SS-A-666. The results of these tests indicate that the method is satisfactory. The committee has, however, prepared several minor changes in the methods.

The Tentative Methods of Testing Asphalt Roll-Roofing Surfaced with Fine Talc, Granular Talc or Mineral Granules, also Asphalt Shingles Surfaced with Mineral Granules (D 228 - 33 T) have been carefully reviewed and a cooperative series of tests have been made to determine what changes are necessary in order adequately to test roofing and shingles conforming to A.S.T.M. specifications on this subject. From the results of these tests and from other criticisms received by the committee, there have been prepared a number of improvements and changes in the test methods.

The Subcommittee on Methods of Fiber Analysis has been carrying on a series of cooperative tests on methods for the identification of rayon fibers. A report describing these studies was presented and recommended for publication in the 1937 annual report of the committee.

The two proposed methods of test for sieve analysis of granular, and non-granular, mineral surfacing for asphalt roofing and shingles, published as information last year, have been given further study and with certain minor changes are being recommended as tentative standards.

Committee D-11 on Rubber Products

Committee D-11 had decided to undertake work on liquid rubber products and an organization meeting of a new subcommittee on this subject was held in Chicago. The subcommittee decided to give its attention to the formulation of standard methods for the evaluation of (1) rubber cements and (2) rubber latex. The work on cements will include the standardization of tests for viscosity measurements and for the determination of total solids. A test program was outlined which will require the preparation of samples of different standardized viscosities to be distributed to a group of cooperating laboratories. Determinations will be made of the total solids present and viscosity of the liquid rubber by methods used in each of the laboratories; then a survey of the test procedures used will be made by the committee. Arrangements have also been made for a cooperative series of tests by various interested laboratories on latex obtained from one source of supply, which will include 60 per cent latex and latex having normal concentration. Tests will include the following: color, total solids, dry rubber content, ammonia, and hydrogen ion concentration.

The Subcommittee on Mechanical Rubber Hose plans to undertake a consolidation and amplification of the methods of testing rubber hose. The two existing A.S.T.M. Standard Methods D 379 and D 380, originally intended for testing rubber hose of braided and wrapped constructions, respectively, will be combined into a single set of test procedures and the present methods will be supplemented by additional tests now required for various types and other constructions of hose, such as metal lined hose, hose subjected in use to gasoline and other petroleum products, and woven hose, etc.

A canvass of the scope of use of the Specifications for Rubber Gloves (D 120 - 23) has indicated that a very substantial percentage of such gloves are purchased in accordance with these A.S.T.M. specifications. The committee has studied the requirements and will propose minor changes to improve certain features.

The Subcommittee on Insulated Wire and Cable has completed revisions in the Tentative Specifications for Insulated Wire and Cable: Class AO, 30 per cent Hevea Rubber Compound (D 27), and Performance Rubber Compound (D 353). The table on insulation resistance (Table V) will be extended to cover the same range as the present table on test voltages, namely, up to 8000 volts. The moisture absorption test for braids will be eliminated and the dimensional features, particularly as to cross-section, of the test specimens are to be limited.

This subcommittee also reviewed a proposed draft of specifications for tough rubber sheath compound for cables. Specification requirements for heat-resisting compound for rubber insulation were also outlined. This subcommittee also considered the first draft of a new set of methods of test for insulated wire and cable whereby the detailed test procedures for the evaluation of such materials will be included in a standard separate from the purchase specifications. These several matters will be given further study.

The Subcommittee on Rubber Products for Absorbing Vibration gave consideration to a proposed method of test for compression set of vulcanized rubber which involves determination of permanent set by change in load characteristics rather than change in dimensions of specimens.

The Subcommittee on Tests for Properties of Rubber and Rubber-Like Materials in Liquids has reached agreement on details of a test method suitable for laboratory prepared specimens, including conditions of test, requirements for size of specimen, test liquid, type of equipment, methods of measuring increase in weight and volume, and tensile strength. This will be presented in the form of proposed Methods of Testing Vulcanized Rubber for Oil Resistance.

Committee D-15 on Thermometers and Laboratory Glassware

At its meeting the Committee on Thermometers and Laboratory Glassware considered detailed requirements for a new acid heat test thermometer which is intended for use in a method of test being developed by Committee D-2 on Petroleum Products and Lubricants. The specifications will provide for special thermometers graduated in either Centigrade or Fahrenheit degrees, the ranges being —5 to +105 C. with subdivision graduations in 0.5 C., or 23 to 220 F. with subdivision graduations in 1 F.

A revision of the specifications covering the high softening point thermometer for use in connection with the Test for

Softening Point by Ring-and-Ball Apparatus (E 28 - 36 T) was completed for submission to Committee E-1 on Methods of Testing for inclusion in Method E 28. An increase in the temperature range of the thermometer was made last year, the present limits being 30 to 200 C. (85 to 392 F.). The original high softening point thermometer covers a range of 30 to 160 C. (85 to 320 F.). The changes now proposed are to cover more adequately the dimensional details.

The committee also reviewed detailed specification requirements for a new thermometer for use in connection with the Tag closed tester in determining the flash point of lacquer solvents or diluents of low flash point. The specifications will cover special thermometers graduated in either Centigrade or Fahrenheit degrees, the ranges being —20 to +50 C., or 0 to 120 F. Action was taken to submit these proposed specifications to Committee D-1 on Paint, Varnish, Lacquer, and Related Products and to Committee D-2.

The committee has been making a detailed examination of the various requirements for glass apparatus now prescribed in the standards and tentative standards of the Society. This review has resulted in the preparation of desirable changes in certain requirements for the 100-ml. burette used in the Test for Specific Gravity of Pigments (D 153 - 27); also improvements in the illustration of the glass trap used in the dilution test for crankcase oil; and the glass flask used in the test for saponification number of insulating oils. It was also decided to recommend an increase in the upper limit of the wax melting point thermometer from 71 C. (160 F.) to 82 C. (180 F.).

Committee D - 18 on Soils for Engineering Purposes

Committee D-18 on Soils for Engineering Purposes held its second meeting in Chicago during A.S.T.M. Committee Week, March 1-4, at which the details of organization were completed and the first steps taken towards initiation of its technical activities.

The committee adopted by-laws and elected the following officers, who with the members of the Advisory Subcommittee will direct the committee:

Chairman: H. F. Clemmer, Engineer of Materials, District of Columbia

Vice-Chairman: C. A. Hogentogler, Senior Highway Engineer, U. S. Bureau of Public Roads

Secretary: Wesley R. Nelson, U. S. Bureau of Reclamation

Members: A. E. Cummings, District Manager, Raymond Concrete Pile Co.; G. L. Freeman, Consulting Engineer, Moran, Proctor & Freeman; A. T. Goldbeck, Engineering Director, National Crushed Stone Assn.; W. S. Housel, Associate Professor of Civil Engineering, University of Michigan

The committee now comprises upwards of 50 members, including representative engineers and technologists from such fields as foundation engineering, highway construction, producers of various materials used in conjunction with soils, such as in the stabilization of soils, various university men engaged in soil mechanics work and various governmental departments dealing with soils, such as the Bureau of Public Roads, Forest Service, Bureau of Reclamation, Navy Department, U. S. Waterways Experiment Station and the National Park Service. The membership includes representatives of the Soil Mechanics and Foundations Division of the American Society of Civil Engineers. Cooperative relations have also been established with the Highway Research Board of the National Research Council and the American Association of State Highway Officials.

The committee is organizing the following subcommittees which will work in the fields designated by their titles; the chairmen of the respective subcommittees are indicated:

1. Nomenclature and Definitions, W. P. Kimball, Assistant Professor of Civil Engineering, Thayer School of Civil Engineering
2. Soil Classification, E. F. Preece, Branch of Engineering, National Park Service
3. Methods of Sampling Soils, G. L. Freeman, Consulting Engineer, Moran, Proctor & Freeman
4. Methods of Testing the Physical Characteristics of Soils, Harold Allen, Materials Engineer, Kansas State Highway Commission
5. Methods of Testing for Stabilized Soil, F. C. Lang, Engineer of Tests, Inspection and Research, Minnesota Highway Dept.
6. Methods of Testing for Compressibility and Elasticity of Soils, D. M. Burmister, Department of Civil Engineering, Columbia University
7. Methods of Testing for Shearing Resistance of Soils, F .J. Converse, In Charge of Testing Materials Laboratory, California Institute of Technology
8. Methods of Testing for Mechanical Stability of Soils, W. R. Nelson, U. S. Bureau of Reclamation
9. Methods of Testing for Bearing Capacity of Foundation and Subgrade Soils (Load Tests), W. S. Housel, Associate Professor of Civil Engineering, University of Michigan
10. Methods of Testing for Bearing Capacity of Piles (Load Tests), A. E. Cummings, District Manager, Raymond Concrete Pile Co.
11. Methods of Testing Drainage Properties of Soils (Capillarity and Permeability), W. J. Schlick, Civil Engineer, Engineering Experiment Station, Iowa State College.

Regional Meeting

(Concluded from page 4)

of the future should be made with the same precision and understanding that metallic alloys are made today and that lubricants can be made more economically and also of higher quality by the use of petroleum bases carefully refined to assure cleanliness and freedom from impurities and protected by the addition of necessary modifiers.

In his paper on "How to Select a Motor Oil from the Standpoint of the Consumer" W. S. James outlined the more important conclusions to be drawn from the papers presented in the Symposium, and also papers presented in the Symposium on Motor Lubricants held in 1933. It was pointed out that motor oil performance cannot be predicted without knowledge of engine characteristics and that oil viscosity at the operating temperature is the most significant property of engine lubricants. Through lack of full understanding of the problem, the rate of oil replenishment appears to be the item of most interest to the driving public.

In concluding, the author gave his opinion that the best way to select a motor oil from the standpoint of the consumer is for him to consult with representatives of the oil and car manufacturers. He pointed out that while this might seem to be a strange conclusion to present, he was forced to it by the complexity of the problem and the necessity of specialized knowledge of the oils from which a selection is made, the characteristics of the car considered, and the driving habits of the particular customer. Increased knowledge of oils and of car characteristics, and more complete interchange of information is desirable in the solution of this problem.

Calendar of Society Meetings

(Arranged in Chronological Order)

American Chemical Society
Semi-Annual Meeting, April 12-15, Chapel Hill, N. C.

International Association for Testing Materials
International Congress, April 19-24, London, England.

American Society of Civil Engineers
Spring Meeting, April 21-24, San Antonio, Texas; Annual Convention, July 21-23, Detroit, Mich.

American Foundrymen's Assn.
Annual Convention and Exhibit, May 3-7, Milwaukee, Wis.

American Society of Mechanical Engineers
Semi-Annual Meeting, May 17-21, Hotel Statler, Detroit, Mich.; Annual Meeting, December 6-10, Engineering Societies Building, New York City.

American Institute of Chemical Engineers
May 26-28, Royal York Hotel, Toronto, Canada.

American Society of Refrigerating Engineers
June 1-3, French Lick Springs, Ind.

American Water Works Assn.
Annual Convention, June 7-11, Hotel Statler, Buffalo, N. Y.

American Electro-Platers' Society
June 14-17, New York City.

Engineering Institute of Canada
Semi-Centennial Celebration, June 15-17, Windsor Hotel, Montreal, Canada.

Association of American Railroads, Mechanical Division
Annual Meeting, June 16-23, Municipal Auditorium, Atlantic City.

American Institute of Electrical Engineers
Summer Convention, June 21-25, Milwaukee, Wis.

American Association for the Advancement of Science
June 21-26, Denver, Colo.

American Society of Heating and Ventilating Engineers
Semi-Annual Meeting, June 24-26, New Ocean House, Swampscott, Mass.

Society for the Promotion of Engineering Education
Annual Meeting, June 28-July 2, Cambridge, Mass.

Answers to Problems

A NUMBER of comments were received from various members in regard to the answer given to the problem appearing in the December A.S.T.M. BULLETIN on page 18, involving absorption tests on four bricks. The answer for the minimum time required to complete the tests without a conflict in the time schedule was $42\frac{1}{2}$ minutes.

This answer is based on the assumption that the laboratory worker while he was removing one brick from the water would be able simultaneously to insert another brick. Several members assumed that the $2\frac{1}{2}$ minutes allowed for drying and weighing would not permit simultaneous removal and immersion of the specimens.

The answer to the problem on page 20, of the January BULLETIN, in which the paying teller in cashing Mr. Smith's check gave him the number of dollars he should have received in cents and the number of cents in dollars and Mr. Smith after spending \$13.50 found he had left twice the amount of the check, was \$40.95.

If d is the number of dollars the teller should have paid Mr. Smith and c the number of cents, we get the equation $c + \frac{d}{100} - 13.50 = 2\ (d + \frac{c}{100})$. Simplifying, we get part of an equation, $\frac{3d + 76}{98}$, that must equal an integer m and in order that the fraction $\frac{2m - 1}{3}$ can be an integer, m must equal $3n - 1$ where n is an integer. The teller should have paid Mr. Smith $d + \frac{c}{100} = 98n - 58 + \frac{199n - 104}{100}$ and if n equals 1, we find that Mr. Smith should have received \$40.95.

PERSONALS

. . . News items concerning the activities of our members will be welcomed for inclusion in this column.

D. S. JACOBUS, Advisory Engineer to the Babcock & Wilcox Co., New York City, has been awarded the Morehead Medal of the International Acetylene Assn.

A. N. JOHNSON, formerly Dean, College of Engineering, University of Maryland, is now Dean Emeritus.

R. O. GRIFFIS is now connected with the Bethlehem Steel Co., Inc., as Research Engineer. He was formerly Sheet Metallurgist, The Youngstown Sheet and Tube Co.

NICHOLAAS T. F. STADTFELD is now with the Board of Water Supply, New York City. He was formerly Director, Fort Peck Lab., U. S. Engineer Office, Fort Peck, Mont.

LESTER A. H. BAUM, who was Chemist, U. S. Bureau of Mines, Pittsburgh, Pa., is now connected with the Research Laboratories of the Johns-Manville Corp., Manville, N. J.

E. N. KLEMGARD, formerly consulting lubrication engineer, Pullman, Wash., is now Director of Manufacturing, Panther Oil & Grease Mfg. Co., Fort Worth, Texas.

R. W. BOYD, formerly Engineer, Turner Construction Co., New York City, is now Assistant Executive Director, Temporary Emergency Relief Administration, New York City.

HYMAN BORNSTEIN, Director of Laboratories, Deere & Co., Moline, Ill., has been nominated for president of the American Foundrymen's Assn., and James L. Wick, Jr., President and General Manager, Falcon Bronze Co., has been nominated for a director.

B. L. MCCARTHY, Metallurgist, Wickwire Spencer Steel Co., Buffalo, has been appointed chairman of a new division of the Wire Association devoted to cold working of metals and cold finished products.

PAUL D. MERICA, Vice-President, International Nickel Co., Inc., delivered the Howe Memorial Lecture of the American Institute of Mining and Metallurgical Engineers in February.

C. E. MACQUIGG, former representative of the Union Carbide and Carbon Research Labs., Inc., on several A.S.T.M. committees, who was Director of Research with this company, has been chosen Dean of Ohio State University's College of Engineering. He will assume his new position on July 1.

W. P. EDDY, JR., Chief Metallurgist, General Motors Truck Corp., Pontiac, Mich., and secretary, Detroit Chapter, is to prepare the American Foundrymen's Association exchange paper for the 1937 meeting of the French Foundry Technical Association, and O. W. ELLIS, Director of Metallurgical Research, Ontario Research Foundation, is to present the A.F.A. exchange paper before the Institute of British Foundrymen.

At the annual meeting of the American Institute of Mining and Metallurgical Engineers held recently in New York City, the Anthony F. Lucas Medal for distinguished achievement in improving the technique and practice of finding or producing petroleum was presented to J. EDGAR PEW, Vice-President, Sun Oil Co.

WATSON DAVIS, Director, Science Service, was awarded a Fellowship at the recent meeting of the American Institute of the City of New York, conferred for outstanding service in the interpretation of science to laymen.

L. M. LAW, formerly Asphalt Technologist, Shell Petroleum Corp., St. Louis, Mo., has severed his connections with the company and is now engaged in consulting practice.

NEW MEMBERS TO MARCH 13, 1937

The following 80 members were elected from January 23 to March 13, 1937:

Company Members (9)

CARBIDE AND CARBON CHEMICALS CORP., E. T. Crawford, Jr., Chemical Engineer, South Charleston, W. Va.

DENVER & RIO GRANDE WESTERN RAILROAD CO., THE, Ray McBrian, Engineer of Tests, Equitable Building, Denver, Colo.

HARTFORD-EMPIRE CO., J. C. Hostetter, Vice-President, Hartford, Conn.

INTERNATIONAL PRINTING INK CORP., THE, J. B. Davis, 432 W. Forty-fifth St., New York City.

JELLIFF MANUFACTURING CORP., THE C. O., H. H. Rennell, Secretary and Treasurer, Southport, Conn.

MIDWEST PIPING AND SUPPLY CO., INC., W. G. Hooper, Vice-President, 1450 S. Second St., St. Louis, Mo.

SOCIETA ITALIANA RESINE, Via Dante, 16, Milan (101), Italy.

SOLAR COMPOUNDS CORP., E. M. Paschall, Sales Engineer, 1201 W. Blancke St., Linden, N. J.

UNITED ENGINEERING AND FOUNDRY CO., H. H. Talbot, Senior Engineer, First National Bank Building, Pittsburgh, Pa.

Individual and Other Members (65)

ALLEN, O. F., Consulting Engineer, 117 Liberty St., New York City.

ALLEN, T. E., Secretary-Manager, American Automobile Assn., Contest Board, Washington, D. C. For mail: 5708 Broad Branch Road, N. W., Washington, D. C.

ASHDOWNE, W. T., Technical Service, Michigan Alkali Co., Wyandotte, Mich.

BATES, H. CLIFFORD, Chief, Fibre Products Laboratory, Corning Glass Works, Corning, N. Y.

BENGTSON, J. E., Mechanical Engineer, Pacific Car and Foundry Co., Renton, Wash.

BRALEY, S. A., Fellow, Mellon Institute of Industrial Research, Pittsburgh, Pa.

BRISCH, MICHALE, JR., Vice-President, Brisch Brick Co., 228 N. La Salle St., Chicago, Ill.

BUNTE, A. H., Materials Engineer, City Testing Laboratory, City and County of Denver, 811 Larimer St., Denver, Colo.

CADY, W. H., Chief Chemist, U. S. Finishing Co., Providence, R. I. For mail: 127 Power St., Providence, R. I.

CARDER, C. H., Director, the Cold Rolled Brass and Copper Assn., Kings Court, 115 Colmore Row, Birmingham, 3, England.

CARSE, D. R., Railroad Steel Representative, Climax Molybdenum Co., 500 Fifth Ave., New York City.

COOPER, S. K., Manager, Specification Dept., Johns-Manville Corp., 22 E. Fortieth St., New York City.

CURTIN, T. I., President and Treasurer, Waltham Foundry Co., 71 Felton St., Waltham, Mass.

DAY, W. A. J., South African Railways and Harbours, Pretoria, South Africa.

DELAWARE RIVER JOINT TOLL BRIDGE COMMISSION, Louis Focht, Chief Engineer, 526 Broad Street Bank Building, Trenton, N. J.

DIXON, E. O., Metallurgical Engineer, Ladish Drop Forge Co., Cudahy, Wis.

FLANSBURG, R. O., Metallurgist, Belle City Malleable Iron Co., Racine, Wis.

FORST, VACLAV, Limited Co. formerly The Skoda Works, Pilsen, Czechoslovakia.

GANTNER, H. L., Secretary-Manager, Fayette Brick and Tile Co., 109 Cleveland Ave., Fayette, Mo.

GARDNER, E. S., President, The Hartford Electric Steel Corp., 540 Flatbush Ave., Hartford, Conn.

GOSS, N. P., Physicist, Cold Metal Process Co., Youngstown, Ohio.

GREENLY, A. H., Chairman, Official Classification Committee, 143 Liberty St., New York City.

HASTIE, C., Surveyor in Charge, Port of Baltimore, Lloyd's Register of Shipping, 1221 Munsey Building, Baltimore, Md.

HEWETT, C. M., Research Chemist, Pan American Petroleum and Transport Co., New York City. For mail: 3510 Powhatan Ave., Baltimore, Md.

HOGENTOGLER, C. A., JR., Research Associate in Soil Mechanics, George Washington University, Washington, D. C. For mail: 107 Georgia Ave., Beverly Hills, Alexandria, Va.

JOHNSON, N. B., Assistant Chief Engineer, Pullman Standard Car Manufacturing Co., 110th St. and Cottage Grove Ave., Chicago, Ill.

JONES, J. C., Technical Adviser, Arthur Seligman and Co., Inc., RCA Building, 30 Rockefeller Plaza, New York City.

KAUFMANN, M. L., Chemical Engineer, U. S. Reduction Co., East Chicago, Ind. For mail: 5217 Woodlawn Ave., Chicago, Ill.

KELLY, C. W., Assistant Chief Engineer, Detroit Steel Products Co., 2250 E. Grand Boulevard, Detroit, Mich.

KERN, L. J., Plant Manager, Lewis Asphalt Engineering Corp., Rahway, N. J.

KIMBALL, W. P., Assistant Professor of Civil Engineering, Thayer School of Civil Engineering, Dartmouth College, Hanover, N. H.

KINSLEY, CARL, Consulting Electrical Engineer, 508 Belvedere Ave., Plainfield, N. J.

LARIMER, E. I., Estimator, Baldwin Locomotive Works, Eddystone, Pa. For mail: 155 Abbottsford Road, Germantown, Philadelphia, Pa.

LAUB, E. W., President, Pacific Rubber and Tire Manufacturing Co., 4901 E. Twelfth St., Oakland, Calif.

LEROY, C. H., Secretary, The Rayon and Synthetic Yarn Producers Group, 51 Madison Ave., New York City.

LOTTIER, L. F., Assistant Metallurgist, The Peoples Gas Light and Coke Co., Chicago, Ill. For mail: 366 Peoples Gas Building, Chicago, Ill.

LOVE, LOUIS G., General Manager, The National Lime and Stone Co., First National Bank Bldg., Findlay, Ohio.

MEMPHIS, CITY OF, LIGHT AND WATER DIVISION, T. H. Allen, Chairman, Goodwyn Institute Building, Memphis, Tenn.

MILLER, J. C., President, J. C. Miller Co., 528 Lake Michigan Drive, Grand Rapids, Mich.

MISKELLY, RAYMOND E., In Charge of Research Laboratory, Plymouth Cordage Co., North Plymouth, Mass.

MORRISON, ALEXANDER, Chief Chemist, American Woolen Co., Administration Building, Andover, Mass.

PATCH, R. H., Treasurer, E. F. Houghton and Co., 240 W. Somerset St., Philadelphia, Pa.

PFEIL, L. B., Metallurgist, The Mond Nickel Co., Ltd., Research and Development Department Laboratory, Wiggin St., Birmingham, England.

POHLMANN, E. F., Chief Testing Engineer, The Peoples Gas Light and Coke Co., Chicago, Ill. For mail: 3921 S. Wabash Ave.

PRATER, B. H., Chief Engineer, Union Pacific Railroad Co., 1416 Dodge St., Omaha, Neb.

REYNOLDS, W. H., President, American Instrument Co., 8010 Georgia Ave., Silver Spring, Md.

RUNYAN, W. B., President, The Dayton Malleable Iron Co., Dayton, Ohio.

SCHWARTZ, ISRAEL, Chief Chemist and Executive, Bendiner & Schlesinger, Inc., Tenth St. and Third Ave., New York City.

SCOFIELD, FRANCIS, Chemist, National Paint, Varnish and Lacquer Assn., Inc., 2201 New York Ave., N. W., Washington, D. C.

SEAGREN, JOHN, Chief Engineer, Atlas Imperial Diesel Engine Co., 1000 Nineteenth Ave., Oakland, Calif.

SHAFFER, S. S., Chief Chemist, Humble Oil and Refining Co., Baytown Refinery, Baytown, Tex.

SMALLEY, B. M., Vice-President, Joslyn Manufacturing and Supply Co., 3700 S. Morgan St., Chicago, Ill.

SMITH, C. S., Research Metallurgist, The American Brass Co., Research Laboratory, Waterbury, Conn.

STEINEBACH, F. G., Editor, *The Foundry*, Penton Publishing Co., 1213 W. Third St., Cleveland, Ohio.

STOTZ, N. I., Metallurgical Engineer, Universal-Cyclops Steel Corp., Titusville, Pa. For mail: 426 Tenth St., Oakmont, Pa.

SWARD, G. G., Chemist, National Paint, Varnish and Lacquer Assn., Inc., 2201 New York Ave., N. W., Washington, D. C.

THOMAS, G. G., Engineer of Metal Structures, Atlantic Coast Line Railroad, Wilmington, N. C.

TSCHEBOTAREFF, G. P., Lecturer, School of Engineering, Princeton University, Princeton, N. J.

UNIVERSITY OF NEW HAMPSHIRE, HAMILTON SMITH LIBRARY, Durham, N. H.

VARLEY, J. H., Resident Refinery Manager and Director, Cork Harbour Oil Wharves, Ltd., Chowl House, Haulbowline Island, Cork, Ireland.

WAGGONER, J. H., Research Engineer, Owens-Illinois Glass Co., Muncie, Ind.

WARD, L. A., Assistant Metallurgist, Chase Brass and Copper Co., Inc., Waterbury, Conn.

WELLING, A. H. S., Rhenania-Ossag Mineralöelwerke A. G., 3 Hafenstrasse, Harburg-Wilhelmsburg 1, Germany.

WILLETS, W. R., Chief, Paper Development Laboratory, Titanium Pigment Corp., New York City. For mail: 105 York St., Brooklyn, N. Y.

YALE UNIVERSITY, SCHOOL OF ENGINEERING, S. W. Dudley, Dean, School of Engineering, New Haven, Conn.

Junior Members (6)

ASHWORTH, J. A., Engineer, Bell Telephone Laboratories, Inc., Room J 65, 463 West St., New York City..

COBB, R. V., 122 Maple Road, Stow, Ohio.

LANDIS, G. A., Laboratory Assistant, Ingersoll Rand Co., Phillipsburg, N. J. For mail: 1001 Seneca St., Bethlehem, Pa.

PEEL, A. R., Student Engineer, Scovill Manufacturing Co., Waterbury, Conn. For mail: 127 Hillside Ave., Waterbury, Conn.

PRIOR, D. L., Salesman, Prior Chemical Corp., 420 Lexington Ave., New York City.

YORK, J. T., Purdue University, West Lafayette, Ind. For mail: 690 Waldron St., West Lafayette, Ind.